INTEGRATED OCCUPATIONAL PROGRAM

Program of Studies/Curriculum Guide

SCIENCE 26

INTERIM – 1991

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ADDENDUM

Addendum to Integrated Occupational Program Program of Studies/Curriculum Guides 26-Level Courses

COMMUNITY PARTNERSHIPS

School administrators and teachers are advised that the **APPLICATION FOR APPROVAL OF WORK SITES/STATIONS** (Parts A and B) must be completed for each work site/station at which an Integrated Occupational Program (IOP) student is placed.

In addition, each student involved in any off-campus IOP learning activity must be registered by the school/school jurisdiction as being placed in an approved work site/station.

Specific procedures and legislation about work experience (community partnerships) is provided in the following documents:

Alberta Education Program Policy Manual
(Available upon written request from Central Support Services,
11160 Jasper Avenue, Edmonton, Alberta, T5K 0L2.)

Work Experience Program: Teacher Resource Manual Junior and Senior High School,
Alberta Education, 1990
(Available from the Learning Resources Distributing Centre,
12360-142 Street, Edmonton, Alberta, T5L 4X9.)

Science 26

Program of Studies/Curriculum Guide

Grade 11

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NOTE

CURRICULAR DOCUMENT FORMAT

To provide educators with a comprehensive overview of the Integrated Occupational Program, all IOP curricular documents have adopted the format of combining the Program of Studies and Curriculum Guide into one document. The shaded statements or segments within this document indicate the prescriptive contents of the program of studies. All other advice and direction provided are suggested only.

The terminology and format used in this document reflect policy in effect when IOP curriculum development began in 1987.

METRICATION POLICY

It is the policy of Alberta Education that "SI units become the principal system of measurement in the curriculum of the schools in the province". In preparing students for transition to the workplace where imperial/U.S. measurements may still be in use, both SI metric and other units of measurement are addressed in the practical arts/occupational component of the Integrated Occupational Program.

The comparison/teaching of metric units with other units of measurement should be restricted to those that are relevant to student needs as reflected by common usage in course-related workplaces.

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RATIONALE

The Integrated Occupational Program (IOP), developed as an outcome of the *Secondary Education in Alberta* (June 1985) Policy Statement, is a program for students who have experienced difficulty in learning. The program consists of both core and complementary courses designed to develop concepts, skills and attitudes necessary for everyday living. The Policy Statement states that a Certificate of Achievement will be awarded to those students who, because of their abilities and needs, have taken the Integrated Occupational Program. The certificate will recognize their achievement in the program.

The Integrated Occupational Science Program provides a two-course sequence in science known as Science 16-26. Science 16 allows students to meet the credit requirements of the Certificate of Achievement. Science 26 allows students to develop further their knowledge and skills in science, and facilitates transfer to the General High School Diploma Program.

The Science 16-26 program provides for the development of essential concepts, skills and attitudes in science that will enable students to function successfully in the home, classroom, workplace and community. The program is activity-based, and addresses the need for students to be able to transfer and apply specific scientific concepts and skills to more generalized situations in everyday life and the world of work. This approach is intended to foster an appreciation of science for its usefulness and relevance, and thus motivate students to participate in the learning process.

As science and technology affect our lives in so many ways, it is necessary for students to appreciate and understand the dynamic relationships that exist among science, technology and society. Students need to understand how science is used in technology, and how technology affects the quality of our life and the health of our planet. Students also need to understand the potential value of technology as well as problems that may arise from its use. Societal issues involving science and technology have been integrated throughout this science program. Community partnerships provide opportunities for students to become involved in the community by way of meaningful activity linked to the science program.

Students are often unaware of strategies they may generate and employ to become more efficient in their cognitive functioning. Evidence supports, however, that students with learning difficulties can perform strategically if taught to do so. Thinking strategies that foster effective behaviours in planning, organizing and self-monitoring are emphasized throughout the program, and provide students with a systematic and logical approach for dealing with a variety of phenomena encountered in their environment. As students learn to understand and control the outcome of tasks demanded of them, confidence in taking risks and accepting challenges will further their ability to solve problems and make informed decisions in everyday life.

Prescribed content within Science 16 and 26 reflects an emphasis on life skills, and has been determined on the basis of the abilities and needs of students for whom the courses were designed. Nevertheless, the philosophy, goals and directions established in the Integrated Occupational Science Program are consistent with those of other regular program science courses. This continuity will assist students in their transition from regular program courses into IOP, and will also facilitate potential transfer of some students from the Science 16-26 program back into regular program science courses.

PHILOSOPHY

The Integrated Occupational Science Program focuses first and foremost on the needs of the learner. As attitude and self-esteem have powerful influences over learning, the program must foster within each student a positive self-concept and a positive attitude toward learning. The concepts, skills and attitudes addressed within the program must:

- provide meaningful and relevant experiences
- be appropriate to student ability
- provide for student success
- enable students to understand their personal environment better.

Students vary in the way they receive, process, recall, apply and communicate information. Each student has a preferred way to approach learning tasks. Instructional planning must include careful assessment of each student's developmental characteristics, knowledge, skills and preferred way of learning. In order to ensure that individual student needs are being met, instructional plans may often need to be adjusted or modified.

An integrated approach suggests the linking together of various scientific skills and strategies into meaningful investigations and activities. Many opportunities are provided for instruction through "thematic study", through the integration of skills "across the curriculum", and through application of skills to "real life" situations. This approach adds a motivational dimension to the program, and provides students with direct assistance in transferring specific skills to more generalized situations. Relevancy to daily living and future employment is emphasized throughout the program.

Although students are at various stages of cognitive development, most students will continue to use concrete operational thinking. Students will depend upon personal experience and personalized content in order to link new ideas with prior knowledge. As the process of analysis must be based on tangible experience, learning activities should begin at the concrete level. High emphasis should be placed on experiential learning involving first-hand investigation. An experiential approach will enable students to relate what they are learning to past experience. While concepts and skills cannot be developed in the absence of supporting facts, the knowledge component of science should not be over-emphasized. Strategies that will assist the learner in progressing from the concrete level of thinking to more abstract thought processes have been provided throughout this *Program of Studies/Curriculum Guide* and the corresponding *Teacher Resource Manual.*

It is intended that the content and process of the Science 16-26 program provide a student-centred, personal and practical approach to science. A program with these emphases will ensure students' success in developing concepts, skills and attitudes that are requisite to responsible participation in the home, classroom, workplace and community.

GOALS OF THE SCIENCE 16-26 PROGRAM

The Integrated Occupational Science Program is designed to assist students in developing and maintaining:

- positive and realistic self-images
- constructive relationships with others
- positive attitudes toward science and lifelong learning.

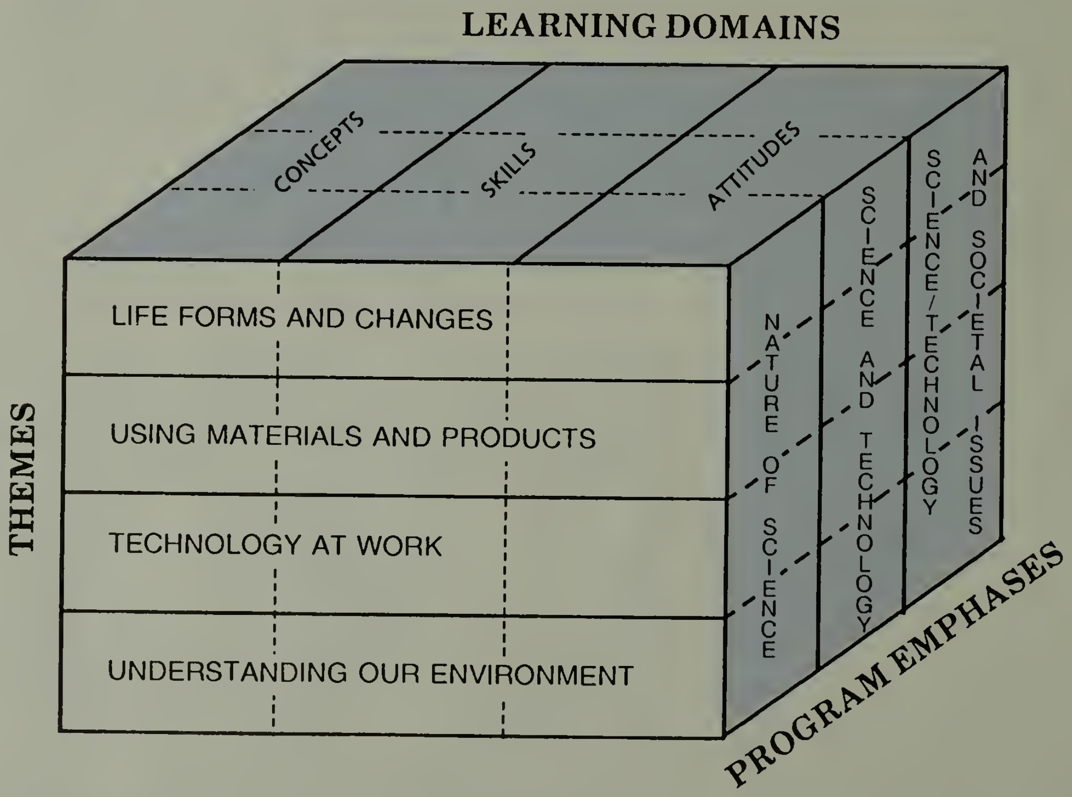
Within the Science 16-26 program, students will be expected to:

- develop essential concepts, skills and attitudes about science that are required for responsible participation in the home, the school, the workplace and the community
- apply scientific concepts and skills to daily life and occupational situations that are experienced both inside and outside the science classroom
- develop critical and creative thinking skills, and apply these skills to a variety of practical situations through processes of scientific inquiry, problem solving and decision making
- develop appropriate knowledge, skills and attitudes in the responsible use of science and technology
- develop communication skills that are used when gathering, interpreting and applying scientific knowledge.

MODEL FOR THE SCIENCE PROGRAM

The model for the Integrated Occupational Science Program illustrates an integration of program dimensions. Three dimensions that provide a basis for program planning are represented in the model. Prescribed components within the science program are shaded.

- The LEARNING DOMAINS, represented on the upper face of the model, provide structure for the science program and include the concepts, skills and attitudes that students will be expected to develop. Prescribed content within each of the learning domains is outlined in the Scope and Sequence (pp. 35-39) and Program of Studies/Presentation of Content (pp. 40-63).
- The PROGRAM EMPHASES, represented on the right face of the model, take into account both the content and intent of science education, and foster the development of knowledge and behaviours that will enable students to interpret and process information in their environment relative to the demands of everyday life. Each program emphasis provides a message about why students are to study particular sets of concepts and skills. Prescribed content that fosters the development of knowledge and behaviours related to each program emphasis is contained within the Scope and Sequence (pp. 35-39) and Program of Studies/Presentation of Content (pp. 40-63).
- The THEMES provide situational and concrete learning experiences where concepts, skills and attitudes are linked with appropriate program emphases. Four themes that address prescribed components within the science program are provided in the *Teacher Resource Manual* (available from the Learning Resources Distributing Centre, see p. 16). The themes are placed on the front face of the model to highlight their importance in planning an integrated program.



LEARNING DOMAINS

The learning domains include concepts, skills and attitudes selected on the basis of frequent task demands placed on students in daily life and work-related situations. The **concepts** component includes major ideas and understandings in science that enable students to interpret objects and events in their natural environment. The **skills** component includes a range of thinking skills appropriate to conducting investigations in science, and useful in a variety of practical situations. The science program fosters the development of student **attitudes** that are associated with the successful study and practice of science, as well as appropriate feelings, opinions, beliefs and appreciations about various aspects of the scientific enterprise.

Although students are expected to develop the concepts, skills and attitudes prescribed for the Science 16-26 program, they are not meant to be addressed separately or sequentially. Rather, they should be addressed within the overall context of themes that provide students with the practical experiences and processing strategies that foster responsible participation in everyday life. Caution should be exercised to avoid over-emphasis on memorization and recall of isolated facts that are of little practical use in daily life.

General learning objectives that correspond to the three learning domains are provided below. **Specific learning objectives** that support the development of concepts, skills and attitudes within thematic contexts are provided throughout the Scope and Sequence (pp. 35-39) and Program of Studies/Presentation of Content (pp. 40-63).

CONCEPTS

Most students will continue to use concrete operational thinking, depending upon personal and tangible experiences in order to link ideas. Therefore, concept development should begin with an operational understanding of ideas fundamental to science, and encourage students to extend their thinking to more abstract levels that are commensurate with their cognitive abilities.

Students will be expected to demonstrate an operational understanding of ideas fundamental to science, including:

- matter has structure and composition, and there is an interaction among its components
- matter and energy are conserved in reaction and living systems
- living organisms are interdependent with one another and with their environment
- life forms exhibit uniquity, diversity, and a changing nature
- biological, chemical and physical systems are in a dynamic state where opposing forces and influences tend to balance each other.

SKILLS

Students need to possess a range of thinking skills in order to investigate natural phenomena, solve practical problems and resolve science-related issues. Some skills involve the use of formal operations (i.e., hypothetical thinking), and must be developed through carefully planned learning experiences that focus on their use. By asking appropriate questions, modelling, and "talking through" complete thought processes, teachers can assist students to develop and consciously use thinking skills that are appropriate to the situations they encounter (see Instructional Mediation and "Teacher Talk", pp. 27-28). Learner ability will determine the degree to which skills are applied at an independent level throughout investigations undertaken in the science program.

The list of skills provided below serves to guide the design of learning experiences and the construction of assessment schemes. These skills are not intended to be developed separately or sequentially, but, rather, concurrently with concept and attitude components stated throughout the Program of Studies.

Students will be expected to demonstrate an ability to:

- distinguish between relevant and irrelevant information
  e.g.,
  - define problems/identify issues
  - set goals by establishing purpose and direction
  - formulate questions to guide research/inquiry
  - identify variables

- gather information or data
  e.g.,
  - use an experimental design or research plan
  - make qualitative and quantitative observations
  - effectively use apparatus and equipment

- arrange or structure information so it can be readily understood or presented
  e.g.,
  - classify
  - order and identify patterns/trends
  - draw charts/graphs/diagrams
  - express data in the form of a simple mathematical relationship

- analyze data or information
  e.g.,
  - identify main ideas/attributes/components
  - identify patterns and relationships
  - identify errors
  - detect bias

- make connections among new ideas and prior knowledge, and generate information beyond that which is given
  e.g.,
  - explain and elaborate
  - predict and hypothesize
  - infer and generalize from the data or information
  - design experiments or devise a plan for research
  - identify further problems, questions and issues to be investigated

- integrate new information with prior knowledge
  e.g.,
  - summarize and communicate findings
  - develop consensus within a group
  - make a decision or develop a conclusion/solution

- assess the logic and quality of ideas/information
  e.g.,
  - consider consequences
  - establish criteria to judge data
  - assess a design or approach taken to inquiry, problem solving or decision making
  - assess the achievement of goals set.

ATTITUDES

Critical to the development of concepts and skills in science is the attitude with which students approach an investigation. Students are often uneasy and hesitant to involve themselves in situations where procedures are not easily determined and outcomes are not evident. The science program must nurture the development of appropriate attitudes through an atmosphere that provides encouragement, flexibility and acceptance.

Students will be encouraged to develop attitudes associated with the successful study and practice of science.

e.g.,
- curiosity
- respect for evidence
- inclination to tolerate uncertainty
- open-mindedness
- critical-mindedness
- perseverance
- creativity and inventiveness
- appreciation for group work
- confidence in personal ability
- respect for accuracy and precision
- concern for safety.

Additionally, students will be encouraged to develop the feelings, opinions, beliefs and appreciations that individuals have formed as a result of interacting with various aspects of the scientific enterprise.

e.g.,
- a positive attitude toward mathematical and scientific process skills
- an appreciation for the utility of computational competence and problem-solving skills
- an appreciation that, in solving problems scientifically, new technologies develop
- an appreciation of the roles that science and technology play in serving human needs
- an appreciation of the need for problem solving and informed decision making at both personal and societal levels
- an appreciation of the contributions science and mathematics have made to our cultural heritage and civilization
- an appreciation of the contributions and limitations of scientific and technological knowledge to societal decision making
- an appreciation that ethical dilemmas may arise from the application of scientific research and/or technological developments
- a sensitivity to the living and non-living environment
- an appreciation of the roles of science and mathematics in explaining the complexity of the natural world.

PROGRAM EMPHASES

The program emphases take into account both the **content** and **intent** of science education, and foster the development of knowledge and behaviours that enable students to interpret and process information in their environment relative to the demands of everyday life. A **Nature of Science** emphasis focuses attention on science as a disciplined way to develop explanations for natural phenomena. A **Science and Technology** emphasis directs attention to the relationship between science and technology, and how science and technology may contribute to the solution of practical problems. A **Science/Technology and Societal Issues** emphasis focuses attention on how science and technology influence and are influenced by societal issues, and how society deals with issues that have a scientific or technological component.

General learning objectives that correspond to each of these program emphases are provided below. **Specific learning objectives** that support the development of related concepts and skills within thematic contexts are provided throughout the Scope and Sequence (pp. 35-39) and Program of Studies/Presentation of Content (pp. 40-63). As themes vary in the degree to which they lend themselves to each of the three program emphases, a primary emphasis has been suggested for each theme.

NATURE OF SCIENCE

A focus on the nature of science and the inquiry process will enable students to understand the way in which scientific knowledge is gathered, as well as use this knowledge in conducting investigations of their own.

Students will be expected to demonstrate an understanding that:

- science is a disciplined way to develop explanations for the events and objects of the natural world
- science is comprised not only of an accumulated body of knowledge, but also of the processes by which that knowledge is developed
- empirical evidence plays an important role in the development of scientific knowledge
- physical laws and conceptual inventions that are theoretical and tentative in nature attempt to explain the universe
- proposed theories may be supported, modified or falsified by experimental evidence
- scientific knowledge is cumulative and subject to change.

Themes with an emphasis on the nature of science will provide opportunities for students to investigate objects and events in the natural world that are relevant to personal experience and need through an active hands-on approach. Particular attention will be placed on developing an understanding of the processes used in conducting scientific inquiry (see A Framework for Conducting Investigations in Science, pp. 25-26). Students will develop appropriate strategies for gathering and interpreting data, and will learn how to conduct experiments by "doing" them.

SCIENCE AND TECHNOLOGY

A focus on science and technology will enable students to understand the interaction between science and technology, and how science and technology may contribute to the solution of practical problems in everyday life.

Students will be expected to demonstrate an understanding that:

- technology facilitates the solving of practical problems
- technological development includes both products and processes
- the functioning of products and processes may be explained using scientific knowledge
- science can be used to advance technology, and technology can be used to advance science
- existing and emerging technologies have application in many everyday and work-related situations
- scientific knowledge and technology have limitations.

Themes with an emphasis on science and technology will provide opportunities for students to recognize that technology is a human activity; that humans engage in technology when they attempt to develop products and/or processes to meet the needs of the individual or society; and that technology not only "solves" problems but also "creates" them. Particular attention will be placed on developing an understanding of the processes used in solving technological problems (see A Framework for Conducting Investigations in Science, pp. 25-26). Students will learn that technological problems can be solved in many different ways, and should gain hands-on experience in solving practical problems of a technological nature by choosing an appropriate problem-solving approach and carrying it through.

SCIENCE/TECHNOLOGY AND SOCIETAL ISSUES

A focus on science/technology and societal issues will enable students to understand interactions that occur among science, technology and society, and how science and technology influence and are influenced by societal issues.

Students will be expected to demonstrate an understanding that:

- science and technology have impact on our lifestyle, occupational choice, environment and welfare
- technological products and processes develop in response to societal needs and wants
- economic, political and ethical perspectives often interact with science and technology and exert significant influence on each
- often the products of science and technology are accepted and used by society before the full extent of benefits/problems resulting from their use can be fully known
- scientific, technological and societal aspects of an issue help to inform the societal decision-making process
- compromises are often needed in order to arrive at workable solutions involving science and technology in society.

Themes with an emphasis on science/technology and societal issues will provide opportunities for students to investigate the impact of science and technology on their personal lives and in their local community. Particular attention will be placed on developing a process for resolving societal issues that have a scientific or technological component (see A Framework for Conducting Investigations in Science, pp. 25-26). Students should develop an understanding that every issue in science exists within a social context, whether personal or public, and through active participation in discussion and debate consider the effects of alternative proposals for action on individuals and society.

THEMES

The themes provide the settings and the tasks where knowledge, concept, skill, attitude and behaviour components are linked together in meaningful investigations. These investigations focus attention on a particular topic or concern, and provide students with practical experiences related to real problems and/or issues affecting their lives.

A well-constructed theme, in addition to providing for the natural integration of a variety of learning objectives, provides opportunities for the teacher to plan activities in all levels of thinking (i.e., recall, application, analysis, synthesis and evaluation). Other advantages of thematic planning and organization of prescribed content include:

- provision for cumulative development of background knowledge and skill, enabling students to relate and transfer learning from one day to the next
- flexibility in responding to student interests and needs. Teachers can address local interests and needs within each theme, as well as individual differences in cognitive development and ability. Learning will be facilitated when students see activities as worthwhile and meaningful
- opportunity for concrete and experiential learning in relevant and meaningful settings
- opportunity to use a wide variety of activities, media and resources
- opportunity to develop strategies and skills in problem solving and decision making through investigations that reflect real issues and problems present in the local community.

Four themes that assure coverage of prescribed content within the science program have been outlined in the Scope and Sequence (pp. 35-39) and Program of Studies/Presentation of Content (pp. 40-63). Further suggestions for planning and organizing these themes are provided in the *Teacher Resource Manual*. The chart below outlines the nature of investigations within themes developed for Science 26, and illustrates their relationship to themes developed for Science 16. A primary emphasis inside the brackets is suggested for each theme.

	SCIENCE 16	SCIENCE 26
Theme A **LIFE FORMS AND CHANGES**	SYSTEMS OF THE HUMAN BODY (NS)	PERSONAL HEALTH AND LIFESTYLE (STS)
Theme B **USING MATERIALS AND PRODUCTS**	CHEMISTRY FOR THE CONSUMER (NS)	MATERIALS WE USE (NS)
Theme C **TECHNOLOGY AT WORK**	USING SYSTEMS AND TECHNOLOGIES (ST)	TECHNOLOGY IN TRANSPORTATION (ST)
Theme D **UNDERSTANDING OUR ENVIRONMENT**	CARING FOR ENVIRONMENT AND RESOURCES (STS)	ENERGY AND THE ENVIRONMENT (STS)

(NS)	Nature of Science
(ST)	Science and Technology
(STS)	Science/Technology and Societal Issues

At the local level, teachers may wish to develop additional or alternative themes to reinforce and expand upon learning objectives or respond to student interests.

INTERPERSONAL SKILLS AND THE SOCIAL SPHERE

High school represents a transitional stage of life for students as they develop the ability to use adult skills. For some students, it may be a time of uncertainty as they strive for independence, yet, at the same time, experience pressures from parents, peers, media and themselves. Response to these pressures may be inconsistent as students continue to develop reflective awareness and the ability to analyze their emotions.

Although schools are not the sole influences on a student's emotional, social and ethical behaviour, the instructional program does affect interpersonal learning.

The Goals of Secondary Education directly state the importance of affective and interpersonal goals when they indicate that students should:

- learn about themselves and develop positive, realistic self-images
- develop constructive relationships with others based on respect, trust, cooperation, consideration and caring as one aspect of moral and ethical behaviour.

Students will vary in their emotional/social development and their ability to cope with personal problems. Behaviours viewed as "problematic" are often simply an indication of a student's lack of sophistication in using adult skills. Classroom instruction must provide a variety of approaches that will encourage students to reflect upon their responses in social situations and to develop productive interpersonal skills. The guidelines that follow have been adapted from Alberta Education's monograph *Students' Interactions, Developmental Framework: Social Sphere* (1988), and are intended to foster affective, interpersonal and moral learning within the classroom:

- Students imitate and thereby implicitly learn to deal with emotions, other people and ethical issues by observing the consistency of adult behaviour. Therefore, it is important that appropriate behaviour be modelled for students. When teachers are respectful of students' dignity, students will respond positively.

- Encourage students to express their opinions and feelings, to ask questions and to accept emotions as they occur in day-to-day life. Through mediated learning (see Instructional Mediation and "Teacher Talk", p. 27), encourage students to examine emotional responses from different frames of reference, and to organize and interpret their own responses as well as the responses of others.

- Provide students with supportive comments, guidance and genuine expressions of concern. Set expectations that are firm and fair, and then believe in the students' ability to meet these expectations and do well. Develop "working agreements" to help tasks flow smoothly, and to ensure that students understand the nature of the instructional tasks they are asked to perform.

- Ensure that classroom management practices and rules are known, upheld, moderate in nature, negotiable, and consistently applied. Responding to the harmful or unjust effects/consequences of a moral transgression is more effective than reference to broken rules or unfulfilled social conventions.

- Recognize that experiential learning is a particularly effective vehicle for teaching interpersonal skills. Although some learning may occur through listening and reading, one best learns to live with other people by living with other people. Cooperative learning techniques are especially useful where students are actively involved in lessons linked to their own needs, interests or experiences.

- Be aware that although teenagers deal with a number of issues, these issues usually come into focus at different times. The issues are not so interdependent that the solution of one of them requires prior solution of others. Help students to integrate various aspects of their lives by encouraging them to recognize how various problems/issues/solutions are often interrelated.

- Assist students to learn skills that are appropriate in differing contexts. Although some students are described as "lacking in social skills", socially maladapted students do not necessarily lack either skills or social involvement; rather, they use inappropriate skills in particular contexts. When directly teaching interpersonal skills, be as concrete as possible, and "build bridges" by linking situations with appropriate actions and behaviours.

- Assist students to focus on the need for a system of shared conventions. As students affirm the social system of conventions, they will view conventions more positively and will become less disruptive in their behaviour.

- Encourage students to interpret and evaluate ethical issues presented to them. Provide opportunities for open discussion and debate, where students interact with their peers. Discuss issues that are "real" to the student.

- Provide students with practical strategies for resolving interpersonal conflict. A framework for social problem solving is provided in the *Teacher Resource Manual*. This framework uses a problem-solving approach in helping students to identify:
  - reasons for the difficulty
  - strategies to avoid the conflict another time.

Student development in the affective and interpersonal domains has been addressed in this curriculum through attitudinal learning objectives that accompany each cluster of concepts and skills in the Program of Studies. Instruction must nurture the development of these attitudes through a variety of approaches appropriate to student interest and maturation. The *Teacher Resource Manual* provides suggestions for developing prescribed attitudes within the context of themes outlined for this program.

REQUIRED AND ELECTIVE COMPONENTS

The required component of the Science 16-26 program includes the concepts, skills and attitudes that all students must acquire. Shaded statements within the Program of Studies/Presentation of Content section of this document (pp. 40-63) outline the required component of the program.

In keeping with the philosophy that concepts, skills and attitudes are more successfully learned if taught within relevant contexts, they are integrated into four themes at each grade level:

- Life Forms and Changes
- Using Materials and Products
- Technology at Work
- Understanding Our Environment.

These themes are developed in the *Teacher Resource Manual*, and include a variety of student activities intended to provide suggestions, models and strategies. Although utilizing these themes will ensure coverage of the required component, teachers are encouraged to add, delete and alter activities to comply with the abilities, needs and interests of students. The "Planning" section of this document (pp. 19-22) provides general guidelines and ideas for adapting a theme to the particular circumstances of the classroom and individual students.

The elective component of the Science 16-26 program permits the teacher to:

- remediate or reinforce concepts, skills and attitudes within the required component
- extend or enrich the program by introducing additional concepts, skills and attitudes considered appropriate to student interest and need.

Students' abilities, interests and needs will largely determine how the elective time will be used. The elective component provides opportunities for varying organizational and instructional strategies that facilitate learning and that are appropriate to each student's developmental stage and preferred way of learning.

Instructional time for the Science 16-26 program should be apportioned:

- 80% Required
- 20% Elective.

SUGGESTIONS FOR THE ELECTIVE COMPONENT

Several factors should be considered in planning content for the elective component:

- student abilities/interests/needs
- curriculum objectives
- availability of suitable learning resources.

For some students, the elective component may be used to provide additional instructional time for study of the themes that support the required component of the program (i.e., extension and remediation). In other instances, however, teachers may wish to enrich their program through the study of optional content. Optional content may involve the student in the study of:

- science competencies required in occupational courses
- a life experience or student interest topic
- a topic of significance in the local community.

Suggestions for developing optional content within Science 16-26 have been provided by way of "Sample Options" outlined in this document (pp. 64-65). Teachers may choose to develop one or more of the sample options when planning content for the elective component, or develop other topics considered appropriate to student interest and need.

OPTIONAL CONTENT FOR SCIENCE 16-26

Science in an Occupation:

FOOD AND MICROBES

Personal Interest or Need:

USING LIGHT AND SOUND

OTHER LOCALLY DEVELOPED TOPIC

There is no requirement that the study of optional content be included as part of the elective component. However, if optional content is developed, teachers must ensure that such content:

- **supports the general learning objectives identified for the science program (see Model for the Science Program, pp. 4-10)**
- **does not detract from the achievement of specific learning objectives within the required component of the program.**

Teachers are encouraged to refer to the Planning section of this document (pp. 19-22) when establishing content for the elective component.

LEARNING RESOURCES FOR SCIENCE 26

STUDENT RESOURCES

BASIC LEARNING RESOURCES

The learning resources listed below address the majority of the goals and learning objectives identified in this *Program of Studies/Curriculum Guide*. Because of the modular format of the learning resources, they have been listed separately for each theme within the science program.

Theme A: Personal Health and Lifestyle

Hutton, Glen, ed. *Food Power.* ISIS Individualized Science Instructional System (Booklet). Revised. Scarborough, Ontario: Globe/Modern Curriculum Press, 1989.

Theme B: Materials We Use

Hutton, Glen, ed. *Materials and Molecules.* ISIS Individualized Science Instructional System (Booklet). Revised. Scarborough, Ontario: Globe/Modern Curriculum Press, 1989.

Theme C: Technology in Transportation

Hutton, Glen, ed. *Arrive Alive.* ISIS Individualized Science Instructional System (Booklet). Revised. Scarborough, Ontario: Globe/Modern Curriculum Press, 1989.

Theme D: Energy and the Environment

Hutton, Glen, ed. *Energy for Living.* ISIS Individualized Science Instructional System (Booklet). Revised. Scarborough, Ontario: Globe/Modern Curriculum Press, 1989.

SUPPORT LEARNING RESOURCES

The learning resources listed below assist in addressing some of the learning objectives identified in this *Program of Studies/Curriculum Guide*. Because of the modular format of the learning resources, they have been listed separately for each theme. Multiple copies (but not necessarily class sets) of each resource may be desired.

Theme A: Personal Health and Lifestyle

Mooney, Libby and Andy Rivers. *Sports Science.* Science at Work Series, Third Edition (Booklet). Harlow, England: Longman Group Limited, 1989.

Theme B: Materials We Use

Goulcher, Pat. *Fibres and Fabrics.* Science at Work Series, Third Edition (Booklet). Harlow, England: Longman Group Limited, 1989.

Theme C: Technology in Transportation

Rowlands, David and George Snape, eds. *Structures and Machines.* Science at Work Series, Third Edition (Booklet). Harlow, England: Longman Group Limited, 1990.

Theme D: Energy and the Environment

Rowlands, David and George Snape, eds. *Energy*. Science at Work Series, Third Edition (Booklet). Harlow, England: Longman Group Limited, 1990.

OTHER LEARNING RESOURCES

A listing of other learning resources potentially useful in implementing the Science 26 program, but which have not undergone the standard review procedures of Alberta Education is provided in the *Teacher Resource Manual*. The responsibility for evaluating these resources prior to selection and use rests with the local jurisdiction according to local policy.

TEACHER RESOURCES

The teacher support publication listed below (and available through the Learning Resources Distributing Centre) is designed to assist classroom teachers to implement the Integrated Occupational Science 26 Program. The publication provides teaching strategies and sample activities that structure the development of concepts, skills and attitudes outlined in the Program of Studies, and supports thematic instruction in four areas described as covering the required component of the program.

Alberta Education. *Science 26 Teacher Resource Manual.* Edmonton, Alberta: Alberta Education, 1991.

The teacher resources listed below are designed to assist classroom teachers in using the BASIC and SUPPORT learning resources.

ISIS Individualized Science Instructional System

Hutton, Glen, ed. *ISIS Individualized Science Instructional System Teacher Resource Guide*. Revised. Scarborough, Ontario: Globe/Modern Curriculum Press, 1989.

Hutton, Glen. *Arrive Alive, Evaluation and Resource Package*. Scarborough, Ontario: Globe/Modern Curriculum Press, 1990.

Hutton, Glen. *Energy for Living, Evaluation and Resource Package*. Scarborough, Ontario: Globe/Modern Curriculum Press, 1990.

Hutton, Glen. *Food Power, Evaluation and Resource Package*. Scarborough, Ontario: Globe/Modern Curriculum Press, 1990.

Hutton, Glen. *Materials and Molecules, Evaluation and Resource Package*. Scarborough, Ontario: Globe/Modern Curriculum Press, 1990.

Science at Work Series

Goulcher, Pat. *Fibres and Fabrics Teachers' Guide*. Science at Work Series. Harlow, England: Longman Group Limited, 1989.

Mooney, Libbey and Andy Rivers. *Sports Science Teachers' Guide*. Science at Work Series. Harlow, England: Longman Group Limited, 1989.

Rowlands, David and George Snape, eds. *Energy Teachers' Guide*. Science at Work Series. Harlow, England: Longman Group Limited, 1990.

Rowlands, David and George Snape, eds. *Structures and Machines Teachers' Guide*. Science at Work Series. Harlow, England: Longman Group Limited, 1990.

The safety resource book identified below will assist teachers in establishing appropriate safety procedures for the science program.

Science Education Consultants' Council. *Safety and Organization in School Science Facilities,* A Resource Book for Elementary and Secondary Schools (Second Edition). Edmonton, Alberta: Alberta Education, 1990.

A listing of additional teacher resources potentially useful in implementing the Science 26 program are identified in the *Teacher Resource Manual.*

TECHNOLOGY AND MEDIA

An annotated list of computer software that may be useful in supporting curriculum objectives identified in this *Program of Studies/Curriculum Guide* is provided in Alberta Education's catalogue of *Computer Courseware Evaluations* (Alberta Education, 1986) and annual supplements.

There is a growing collection of media resources (e.g., films, videotapes, kits, pamphlets) that support the development of specific learning objectives within the science program. A listing of media resources potentially useful in implementing Science 26 is provided in the *Teacher Resource Manual.* Teachers may wish to obtain these and other audio-visual materials considered appropriate to the science program by contacting local media services, libraries and government agencies.

ACCESS NETWORK

ACCESS offers a variety of resources and services to teachers. For a nominal dubbing and tape fee, teachers may obtain copies of educational programs directly from ACCESS NETWORK. ACCESS also offers a service called "Night Owl Dubbing". This allows educators to tape selected programs directly from their own televisions.

ACCESS publishes both an *Audio-Visual Catalogue* and a comprehensive schedule of programming, available on request.

For additional information, contact ACCESS NETWORK, Media Resource Centre, 295 Midpark Way S.E., Calgary, Alberta, T2X 2A8 (from outside of Calgary, telephone toll free, 1-800-352-8293; in Calgary, telephone 256-1100).

REGIONAL AND URBAN RESOURCE CENTRES

There are a number of resource/media centres serving the needs of teachers within different geographical areas and jurisdictions across Alberta. Each centre carries audio and visual resources, and publishes its own catalogue listing the resources in its collection. These centres operate as libraries, and lend materials for specified time periods.

A complete list of regional and urban resource centres, addresses and telephone numbers is provided in the *Teacher Resource Manual*.

PLANNING

GENERAL COURSE PLANNING

Themes and their related concepts, skills and attitudes may be sequenced at the teacher's discretion in a developmentally appropriate way. Course planning should establish a conceptual framework consistent with students' interests, abilities, and preferred ways of approaching tasks. The four themes developed in the *Teacher Resource Manual* are intended to be descriptive rather than prescriptive. Teachers may choose to modify these themes or replace them with other locally developed material in addressing individual student needs.

Through cooperative conferencing, teachers may find that students are required to use certain science-related competencies in other courses before they are learned in science class. Joint planning and negotiation with teachers of other courses will be required in establishing an integrated program that places consistent expectations upon the student.

Course planning should focus attention on the nature of science, as well as an understanding of the role of science and technology in society. Instruction must nurture the development of thinking skills, and assist students to acquire appropriate strategies for conducting inquiry, solving problems and making informed decisions. The activities suggested throughout both the *Program of Studies/Curriculum Guide* and *Teacher Resource Manual* are numerous, but by no means exhaustive. **Be prepared to add, delete, and modify activities in adapting instructional materials and methodology to the particular circumstances of the classroom and student.**

TIME ALLOCATION

Science 16 and 26 are each three-credit courses. Instructional time for each course is to be allocated at the discretion of the school or jurisdiction administration to reflect the needs of individual students.

The chart below suggests time distribution among themes developed in the *Teacher Resource Manual.* These suggestions are intended to provide guidance for the teacher.

THEME	ELECTIVE COMPONENT	SUGGESTED TIME ALLOCATION
PERSONAL HEALTH AND LIFESTYLE	REMEDIATION AND/OR ENRICHMENT	$\frac{1}{4}$
MATERIALS WE USE		$\frac{1}{4}$
TECHNOLOGY IN TRANSPORTATION		$\frac{1}{4}$
ENERGY AND THE ENVIRONMENT		$\frac{1}{4}$

COMMUNITY PARTNERSHIPS

The science program must enable students to recognize the relevance of scientific knowledge in daily life experiences within the home, community and work environments. Within this context, students will be expected to demonstrate competencies that will enable them to:

- apply scientific concepts and skills to practical situations
- set goals, solve problems and make informed decisions
- prepare for a chosen occupation or career.

Community partnerships (i.e., community-based learning experiences) will foster an appreciation of science for its usefulness and relevance. Community involvement will assist students to transfer specific concepts and skills to more generalized situations in everyday life and the world of work. Guest speakers, field trips, job shadowing and mentorship are a few examples of meaningful community associations.

Suggestions for relevant community partnerships in the science program include:

- inviting guest speakers from government, business, the professions and the trades to discuss topics related to those studied in thematic investigations

- visiting local business and industry for first-hand observation and "real life" experience in areas related to the themes studied

- walking through the community in search of practical applications made of concepts and skills being studied

- investigating career and employment opportunities in areas that require specific scientific competencies (e.g., job shadowing, mock employment interviews).

Community agencies, groups and facilities that may provide meaningful contributions to the science program include:

- service groups concerned with personal and environmental health (e.g., doctors, nurses, nutritionists, pharmacists, social workers, police officers, agriculturalists, wildlife officers)

- government officials (e.g., councillors, MLA's)

- local businesses and industries that make application of scientific concepts and skills (e.g., hair care, dry cleaning, automotives, agriculture, food preparation, construction, electrical repair)

- local utility plants (e.g., power generating plants, sewage treatment plants, water purification plants, waste disposal sites)

- natural phenomena (e.g., local river valley, meadow, or wooded area).

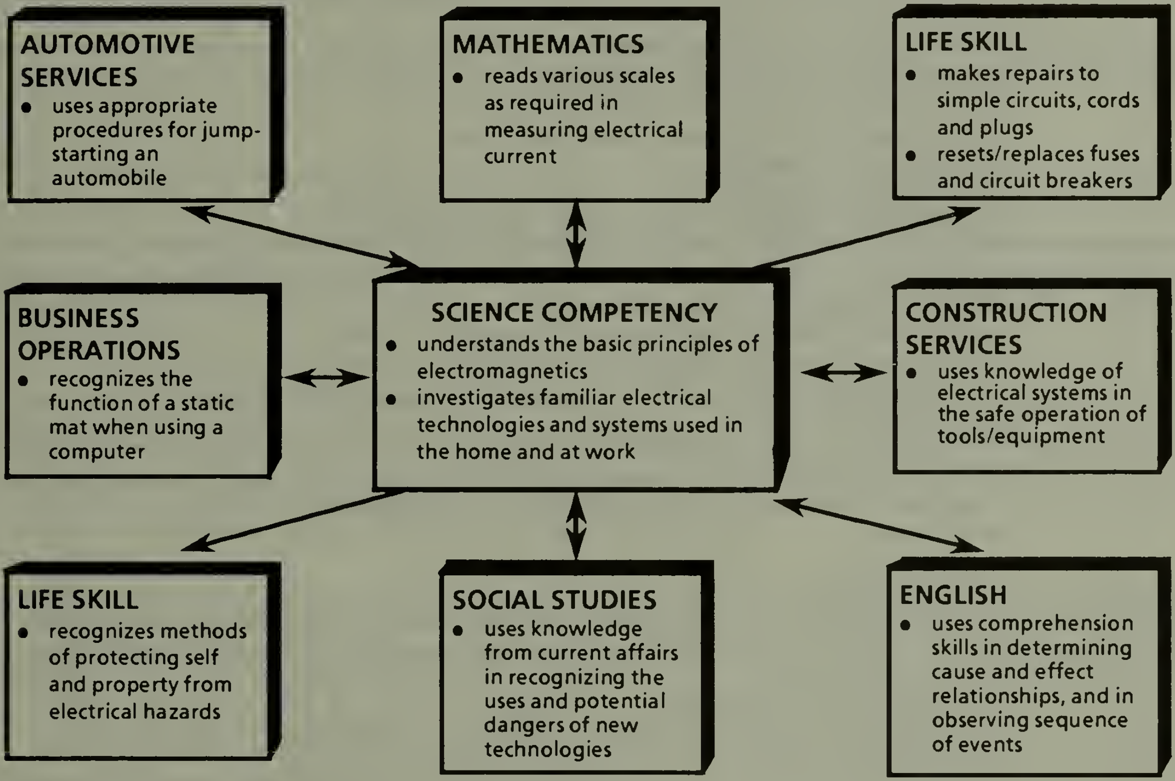
Additional suggestions for inviting members of the community into the classroom, or having students involved in the community by way of meaningful activity linked to science are provided within the *Teacher Resource Manual.* These suggestions may be effective in furthering the objectives of each theme, as well as in reducing classroom barriers to "real life" experience.

CURRICULAR INTEGRATION

The science program should facilitate the development of effective problem-solving and decision-making behaviours by providing learning experiences that reflect and build upon the demands of home and school. Course content is presented within the context of its application in daily living, the occupational program and other academic disciplines. Curricular integration will become a motivating factor as students recognize the relevance and utility of course content. Student ability to transfer concepts, skills and attitudes to a variety of situations in everyday life and the world of work will improve as a result of contextualized learning experiences that link prescribed content with "real life" applications.

Teachers must be familiar with science competencies required of students in everyday life, the occupational program and other academic disciplines. Cooperative planning and conferencing with other teachers is central to understanding differing contexts in which basic concepts and skills are used, and will assist teachers in providing practical learning experiences that encourage transfer of knowledge and skill.

EXAMPLES OF CURRICULAR INTEGRATION BASED ON A SCIENCE COMPETENCY



AUTOMOTIVE SERVICES
- uses appropriate procedures for jump-starting an automobile

MATHEMATICS
- reads various scales as required in measuring electrical current

LIFE SKILL
- makes repairs to simple circuits, cords and plugs
- resets/replaces fuses and circuit breakers

BUSINESS OPERATIONS
- recognizes the function of a static mat when using a computer

SCIENCE COMPETENCY
- understands the basic principles of electromagnetics
- investigates familiar electrical technologies and systems used in the home and at work

CONSTRUCTION SERVICES
- uses knowledge of electrical systems in the safe operation of tools/equipment

LIFE SKILL
- recognizes methods of protecting self and property from electrical hazards

SOCIAL STUDIES
- uses knowledge from current affairs in recognizing the uses and potential dangers of new technologies

ENGLISH
- uses comprehension skills in determining cause and effect relationships, and in observing sequence of events

Basic principles governing the operation of electromagnetic systems are developed in science and related to their applications in other areas. While in this instance application is shown in all subject areas, some competencies may have a more limited range of applications.

The Program of Studies/Presentation of Content section of this document (pp. 40-63) provides suggestions for relating prescribed content to daily life skills (Column 2) and to applications in other subject areas across the curriculum (Column 3). The *Teacher Resource Manual* provides additional suggestions and approaches for linking prescribed content with practical applications.

PLANNING AN INTEGRATED UNIT OF INSTRUCTION

A variety of factors need to be considered when expanding upon an existing theme or developing a new thematic unit. The guidelines that follow provide a useful structure for developing integrated units of instruction.

1. Identify a possible theme, based on:
    - curriculum goals and objectives
    - student needs/interests/abilities
    - availability of suitable learning resources.

2. Develop a purpose for the theme. Include:
    - thematic objectives
    - a checklist of concepts, skills and attitudes that lend themselves to the theme. Identify those skills that may need some focused/direct teaching.

3. Consider suitable resources:
    - books, pamphlets, monographs
    - appropriate laboratory equipment
    - computer software, films, videos
    - resources from the occupational program
    - community resources
    - newspapers and periodicals
    - other resources that students may have access to.

4. Design activities:
    - allocate activities to the purposes developed in Step 2
    - develop a checklist of process objectives to be emphasized in the theme
    - separate activities into lessons with general and specific objectives
    - sequence the lessons.

5. Develop ongoing strategies to build community partnerships into your theme:
    - field trips
    - guest speakers.

6. Plan for evaluation:
    - students' self-evaluations
    - teacher's ongoing (formative) and summative evaluations
    - peer evaluations.

7. Share the unit:
    - celebrate achievement
    - share thematic units with other teachers
    - expand, update and revise units as they are used
    - develop strategies to evaluate the updated and revised activities with a variety of student groups.

METHODOLOGY

WORKING WITH THE RELUCTANT LEARNER

All students are capable of successful learning experiences in science. Students differ, however, in their rate and style of learning, as well as in the degree of support and encouragement required. Previous experiences, perceptions of the value of science, and the fear of being wrong or making a mistake are all factors that may cause students to look upon the science classroom as a place where personal inabilities are exposed. **A supportive learning environment will assist students in dealing with these attitudes. In order to meet the interests and abilities of individual students, the program must be varied in materials, content, pace and instructional methods.**

Guidelines for establishing a supportive learning environment that nurtures the development of appropriate attitudes are provided in "Interpersonal Skills and Social Sphere" (pp. 11-12). Additional suggestions for decreasing anxiety levels and building appropriate attitudes within the science classroom are provided below.

- Become familiar with the learning characteristics (e.g., reading level, interests, preferred learning style) of individual students through background information, interviews and direct observation.

- Choose topics for investigation that are relevant to everyday life. Be aware that students are concerned with the immediate and practical effects of science. Relate concepts and skills studied to personal experience. Make an effort to ensure that terminology commonly used is part of the students' working vocabulary. Focus attention on what students consider interesting or important. Familiar problems/issues will "make sense" more readily than unfamiliar ones.

- Provide abundant opportunities for learning at the concrete level. Plan activities that emphasize a "hands-on" and multisensory approach to the learning of science (e.g., use a stethoscope to hear heart rate and take pulse to feel heart rate). Encourage students to verbalize and discuss relationships that are discovered. Assist students to transfer and apply relationships discovered to a variety of related life situations.

- Avoid unnecessary tension in the classroom by being patient, receptive and understanding. Ensure that students recognize that making a mistake is acceptable, and that such occurrences provide valuable learning experiences. Urge students to ask questions, and to accept that "there is no such thing as a stupid question". Remember that an offhand remark about a question being "easy" may be interpreted by a student as "If it's easy and I'm confused, then I must be stupid". Recognize and accept alternative interpretations/explanations that students may formulate.

- Match the reading level of resources and materials used to that of the students. Provide assistance and support in developing necessary science vocabulary. Monitor students' understanding of materials read on an ongoing basis, and take steps when necessary to ensure that reading deficiencies do not prevent students from learning science.

- Group for instruction through a variety of organizational patterns that will facilitate meeting the needs of individual students. Ensure that grouping patterns remain flexible, allowing student movement from group to group. Include learning activities that require whole group, small group, and one-to-one (teacher to student and/or student to student) involvement. Use such resources as the buddy system, peer tutoring and aides.

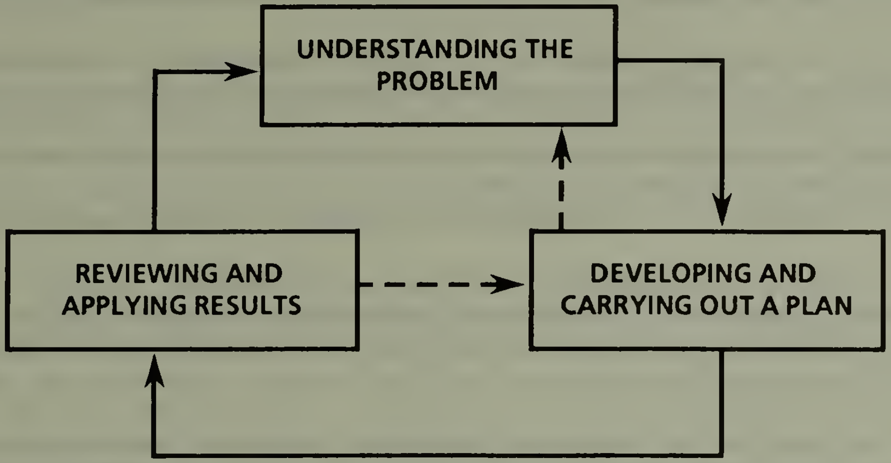
- Ensure that investigative activities are well structured, recognizing the organizational problems and language deficiencies that some students may have. Provide students with direction when gathering data for investigation. After the data has been gathered, use leading questions to guide students in making a reasonable interpretation and evaluation of the results. Encourage students to discuss their results with other members of the class. Given the complex cognitive nature of investigative design, the independent design of laboratory investigations and research projects may be inappropriate for most learners within the Integrated Occupational Program.

- Use a variety of assessment and evaluation strategies. While paper-and-pencil tests are an effective way of evaluating some learning outcomes, their use does not always enable students to demonstrate gains made. Provide opportunities for students to demonstrate acquired knowledge and skills in a variety of ways. Effective evaluation should draw upon information gathered through teacher observation, student demonstration and project work. Additional strategies for student evaluation are provided in the section on "Evaluation" (pp. 33-34).

- Recognize that while most attitudinal problems are brought about through past experiences that may foster natural apprehension of new or challenging situations, there are other emotional symptoms that may be related to deeper personal or social problems. Personal interviews with students will assist in identifying such instances, and may also establish a need for consultation (or referral) with counsellors who have expertise in dealing with such problems.

A FRAMEWORK FOR CONDUCTING INVESTIGATIONS IN SCIENCE

A framework for inquiry and problem solving is diagrammed below. Although the framework provides an overall structure that can help students to understand the processes used in conducting an investigation, it should not be interpreted as a series of fixed and rigid stages. There are many ways to approach a problem, and the sequence of steps used will depend upon individual problems and individual students. Students may not always go through the steps in the order suggested, nor even use all steps in some problem situations. Nevertheless, students should recognize that conducting an investigation involves a series of interrelated actions that lead to an outcome or solution.


UNDERSTANDING THE PROBLEM
REVIEWING AND APPLYING RESULTS
DEVELOPING AND CARRYING OUT A PLAN

The framework for inquiry and problem solving in science parallels the framework used for conducting investigations and solving problems in other subject areas within the Integrated Occupational Program. The framework provides a general "plan for action" that can guide students through a broad range of investigative activities (e.g., problem solving, troubleshooting, inquiry, decision making, library research). As students become familiar with the framework and discern similarities among the actions taken in different forms of investigation, they will become more likely to transfer skills learned in specific contexts to more generalized situations where methods and outcomes may be uncertain. Students should recognize how the framework for conducting investigations in science provides a general plan for action that is also effective in guiding investigations in English, mathematics, social studies and the occupational program, and how specific skills used at each stage within the framework will vary according to the nature of the problem or investigation.

Student ability to conduct investigations and solve problems can be enhanced by making students conscious of their thought processes (i.e., metacognitive awareness). Students need to become aware of and discuss how they think in order to become more strategic in their learning repertoires and to monitor their own efforts. Research strongly supports the teaching practice of:

- modelling (talking through) the processes and skills that are appropriate to an investigation
- discussing the processes and skills that the student is presently in the habit of using (i.e., raising the level of metacognitive awareness)
- encouraging students to develop additional strategies that will structure and support the thought process.

Questioning and modelling techniques that can be used to guide students in thinking about problems and in developing effective problem-solving strategies are provided in an ensuing section of this document (see Instructional Mediation and "Teacher Talk", pp. 27-28). Other models and guidelines for conducting a range of investigative activities in science (e.g., inquiry, problem solving, decision making) are illustrated in the *Teacher Resource Manual.*

SUGGESTIONS FOR USING THE FRAMEWORK

Critical to the development of thinking skills is the attitude with which students approach situations where methods may be uncertain and outcomes are unknown. The development of appropriate attitudes must be nurtured through an atmosphere that fosters flexibility and acceptance. Students must learn to accept and appreciate that being perplexed and unsure is often normal when first encountering a challenging situation, and to take risks in the development of particular problem-solving strategies. The guidelines that follow may assist teachers in planning instructional activities that support the development of effective thinking skills.

- Nurture a positive classroom atmosphere. Foster the development of attitudes and behaviours that promote student thinking and ability to monitor progress through an investigation by:

    - encouraging students to be creative, and to generate their own ideas and approaches to gathering information and solving problems
    - providing adequate support and assistance to students, but not solving their problems for them
    - being willing to accept unconventional strategies and solutions
    - challenging students to think critically and justify strategies and solutions
    - being enthusiastic and capable of recognizing the students' desire and perseverance in conducting investigations.

- Share the framework for conducting investigations with students. The framework provides a structure for thought and action, and will enable students to discern similarities among skills that are used in different kinds of investigation.

- Assist students to become aware of a variety of thinking skills and thought processes that are useful in conducting inquiry, solving problems and making decisions. Ask questions that encourage students to discover their own answers, and model (talk through) complete thought processes that are used in different kinds of investigation.

- Encourage students to recognize how the framework for conducting investigations in science provides a general plan for action that can also be used to guide investigations in English, mathematics, social studies and the occupational program, and how specific skills used at each stage within the framework may vary according to the nature of the problem or investigation.

- Keep the framework and strategies for conducting investigations flexible and tentative. While the framework is useful in the structure it provides, encourage students to be creative and experimental in their approach to solving problems.

- Ensure that investigations do not become tedious or unrealistically complex. Data related to the phenomena investigated must be readily available. Cognitive demands of the situation must match the developmental levels of students.

- Select investigations emerging from everyday life that are relevant to the interests and experiences of students. Provide opportunities for students to gather data related to local issues through a variety of methods (e.g., reading, viewing, interviewing), and to consider current perspectives on issues as reflected through local media (e.g., newspapers, periodicals, television, radio).

INSTRUCTIONAL MEDIATION AND "TEACHER TALK"

Recent educational research has focused, in part, on instructional mediation and "teacher talk" in the classroom. Instructional mediation is an interactive process wherein teachers refine their interpretation of tasks to students, as students construct their own interpretations of the tasks and processes being learned. This communication exchange stimulates the development of thinking skills by allowing both teachers and students to contribute to a meaningful learning situation. Lectures, or one-sided explanations, rely on students to be "self-mediating" and to supply their own meaning to processes without the advantage of communication interaction.

Instructional mediation regulates the students' behaviour in terms of the use of strategies and approach to tasks. Emphasis on a strategic view of tasks will encourage students to become independent in the tasks they perform and the processes they use. For example, a strategy for conducting scientific inquiry will enable more students to perform investigations on their own. In addition, such a strategy enables the student to identify for the teacher at what point they need assistance, if they are unable to completely solve the problem.

Instructional mediation can also enhance students' feelings of competency. Students need to see themselves as being successful. Students who feel competent, and who recognize their effort as being effective in learning, are more likely to be persistent in attempting new tasks that are difficult. On the other hand, students who feel incompetent and unsuccessful often require constant praise from external sources. Students who do not recognize that their efforts are effective in the learning process have limited performance goals and are hesitant to engage in any task at which they cannot quickly become successful. Mediation that focuses on the roles of effort and strategy in achieving success will encourage students to extend their learning goals.

Teachers can establish learning environments that foster the development of strategic behaviours and thinking skills by:

- assisting students to identify, analyze and evaluate materials and personal performance
- encouraging students to identify and correct their own errors
- assisting students to pause, revise and clarify at appropriate times
- modelling and encouraging students to use vocalization of thought processes
- encouraging persistence.

The mediation process can also be enhanced through the use of appropriate questioning techniques and by modelling effective behaviours. These approaches are briefly described in the paragraphs that follow.

QUESTIONING TECHNIQUES

Questioning techniques include the use of chains of questions that lead students to discover their own answers. Question chains should begin with focus questions such as:

- What are we looking for?
- What do we want to explain/investigate?
- What do you think might happen if . . . ?
- Why did . . . ?
- What should we do first?
- What is stopping us?

Once students have established the significant pieces of information, questioning is expanded to include:

- What is my next step?
- How will I do that?
- What is the relationship between . . . and . . . ?
- How are . . . and . . . related?
- Why did . . . happen after . . . ?
- What is the likelihood that . . . ?
- What do you notice about . . . ?

Students should also be encouraged to evaluate the thought processes used in completing individual tasks and in conducting an investigation. Ask questions such as:

- How did you know that . . . ?
- What does the data indicate?
- What caused . . . to happen?
- How does . . . apply to . . . ?
- How could you explain . . . in another way?
- How might you use these results?
- How could we make our work easier another time?
- What should we tell others?

Questions that probe and prompt students to process information, rather than fixate at the simple recall level, will encourage students to become actively involved in thinking processes. As students experience success through use of the teacher's chain of questions, they will recognize the importance of the thought processes they have used and develop related strategies that direct their efforts in other tasks.

COGNITIVE MODELLING

Cognitive modelling, as opposed to demonstrating, involves "talking through" a complete process in order to expose thinking processes to the student. While in a demonstration everything turns out as it should, modelling should include false starts, trouble spots, and having to deal with errors. This type of modelling requires teachers to express their thinking processes out loud so that students can see not only how the process is done, but also how difficulties and ambiguities are addressed. As the process is modelled, students should recognize that the teacher's approach may not necessarily be the "best" approach, but simply one way of tackling the problem.

While teachers often model when explaining processes and problems, knowledge and awareness of the value of modelling can serve to refine this process. Asking students where they might begin to solve a problem makes a good starting point. If the reply is "I don't know", an area of difficulty is determined. The mini-processes of "understanding the problem" and "developing a plan" might then be modelled for students.

SAFETY IN SCIENCE

Safety must be a major consideration as students become actively involved in experimental procedures and laboratory settings. An awareness of safety should be developed through a common sense approach. Students should recognize that specific hazards can be avoided through advance planning and an awareness of hazardous materials and situations. No laboratory work should be expected of students if they are not fully aware of possible hazards and preventative measures.

When conducting experiments and investigations, students will be expected to display a concern for safety by:

- following directions exactly as given
- understanding the import of what they are doing
- maintaining order and neatness when using equipment
- using prior knowledge to make judgments
- asking for advice when in doubt.

Students should be encouraged to transfer the safety knowledge and attitudes developed in school to potentially dangerous situations they may encounter at home, at work and in the community.

RESPONSIBILITIES OF THE TEACHER

Teachers must provide adequate supervision of students at all times, and emphasize accident prevention. Students must be alerted to situations they may create that are unsafe or hazardous.

The most effective method of teaching safety is by example. The procedures and attitudes modelled by the teacher influence students more than actually teaching a unit on safety. The teacher must be conscious of the example being set, and through modelling assist students to develop appropriate safety habits and attitudes, including:

- careful observation and alertness at all times
- application of safety procedures and techniques
- advance identification of safety responsibilities associated with experimental procedures that are planned.

RESPONSIBILITIES OF THE STUDENT

Students must be alerted to general safety precautions and procedures early in the science program. Specific hazards and precautions related to the use of equipment and chemicals must be discussed as the materials are used. Students should learn to plan their laboratory investigations and procedures in ways that will minimize the possibility of accidents. All accidents and unexpected events that occur should be reported and discussed with the teacher.

It is advised that a **Student Safety Contract** be issued early in the school year, after students have been alerted to general safety precautions and procedures. Use of a safety contract will increase the students' awareness of personal responsibilities in the safety of self and others. A sample student safety contract is provided in the *Teacher Resource Manual.*

SAFETY GUIDELINES AND POLICIES

Teachers must be familiar with safety policies and statements adopted by their employing board. In the absence of such statements, teachers should be aware of specific hazards that students face in the science program and take suitable precautions to avoid such hazards.

Teachers must also be familiar with policy and information provided in Alberta Education's monograph *Clarification of Statements Prohibiting the Use of Human Body Substances in the Alberta Science Curriculum*, 1988. (Due to the potential risk of infection from hepatitis and AIDS, all activities involving the extraction and analysis of samples of human fluid or tissue are prohibited in Alberta schools.)

Additional safety information that should be available in every school is provided in:

- *Safety and Organization in School Science Facilities, A Resource Book for Elementary and Secondary Schools* (Second Edition) by Science Education Consultants' Council, Alberta Education, 1990.
- *Hazardous Chemicals: Information and Disposal*, a resource by Margaret-Ann Armour, Lois Browne and Gordon Weir, published by the University of Alberta, Edmonton, 1985.

WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM

The Workplace Hazardous Materials Information System (WHMIS) is a hazard communications program designed to protect workers across Canada from injuries and illnesses caused by exposure to chemicals. School jurisdictions must have WHMIS guidelines implemented. WHMIS uses federal and provincial legislation to ensure:

- the labelling of hazardous materials
- the provision of material safety data sheets (MSD's) by suppliers of hazardous materials
- worker education/instruction programs.

WHMIS provides a way for teachers to obtain information about hazardous materials that may be used in the science program. Science teachers should consult WHMIS in order to identify the hazards of various materials and the precautions to take when using these materials. Additionally, all secondary school students should receive instruction about WHMIS, and use the system in their work. WHMIS instruction is probably of greatest value at opportune times before and during students' use of controlled products, rather than as an individual topic of study.

Policy and information on WHMIS is provided in *WHMIS: Abridged Guidelines for Schools*, a resource booklet prepared by the Science Education Consultants' Council, Alberta Education, 1989. Posters, booklets and pamphlets that describe features of WHMIS are available at no cost from the nearest Regional Office of Alberta Occupational Health and Safety.

Other resource materials on WHMIS include a videotape *WHMIS: Working for You* and a reference manual *WHMIS Core Material: A Resource Manual for the Application and Implementation of WHMIS (1989 Revised Edition)*. These materials can be ordered through the Alberta Association of Safety Personnel/Canadian Society of Safety Engineers Provincial Body at the address provided below.

AASP/CSSE Provincial Body
P.O. Box 262, Main Post Office
Edmonton, Alberta
T5J 2J1

USING TECHNOLOGY AND MEDIA IN SCIENCE CLASS

USING TECHNOLOGY

An understanding of the impact and use of technology is essential in preparing students for current and future demands in society. Instructional activities should focus attention on various aspects of technology by providing opportunities for students to:

- learn about technology. Students should develop an awareness of the advantages and limitations of particular technological developments and their impact upon society
- learn with technology. Students should develop the ability to use selected technologies as tools to get work done or as an aid to problem solving (e.g., the hand-held calculator)
- learn through technology. This aspect refers to the use of selected technologies to enhance learning (e.g., computer-assisted instruction, computer-managed learning).

In preparing students for future roles in society, one must recognize the increasing importance of being able to interact with computer technology. To the extent that computer facilities and equipment are available, the science program must provide opportunities for students to:

- develop an understanding of the basic operation of computers
- recognize the basic capabilities, applications and limitations of computers in society
- work independently with prepared computer software appropriate to course/personal development.

Interactive computer software holds promise for application in the science classroom. Its value in organizing and displaying data, generating patterns, and simulating "real life" situations is already evident. As software development continues to expand, students will be able to interact with computer programs in more highly individualized ways while developing concepts and skills in science. Teachers are encouraged to review computer software on an ongoing basis in order to identify resources that address individual student needs and program goals in the most appropriate manner.

Applications of computer conferencing and networking also continue to expand. To the extent that facilities and equipment are available, students should gain first-hand knowledge of how information and ideas are accessed and shared through computer conferencing and networking systems.

USING MEDIA

Teachers are encouraged to use a variety of media materials in the classroom. Media materials that might be used to supplement instruction include:

- newspapers and periodicals
- television programs and video recordings
- films and filmstrips.

As with any resource, media materials should be selected with due consideration for the goals of the program and needs of the learner. Medial materials should be previewed for the accuracy and validity of content, as well as their appropriateness to student interest, experience and needs. The following questions may assist teachers in their selection of media resources for the science classroom.

- Does the resource support the major goals and learning objectives of the science program?
- Does the resource meet individual needs and learning styles?
- Does the resource reinforce, enrich or extend the program?
- Is the content relevant, accurate and current?
- Does the resource provide opportunities for the development of critical thinking skills?
- How appropriate is the timing and delivery?
- Does the media demonstrate abstract ideas?
- How well does the media suit existing teaching/learning needs?
- What kind of preparation is required?
- How might learning be evaluated?
- What forms of follow-up activities will be required?

The advantages and disadvantages of television viewing are often debated, yet the fact remains that educators must prepare students to become critical viewers rather than passive absorbers of information. Television has changed our lives and critical viewing has become an important educational skill. This is especially true for students who may experience difficulty relating to textual material, and who may prefer visual and auditory messages.

Students must be assisted to become critical viewers/readers/listeners of television, newspapers, periodicals, films, videos and other print/electronic media. The classroom should provide opportunities for students to analyze media and the impact of media on their lives and on society. Educators need to teach students the critical viewing/listening/reading skills and related attitudes that will enable them to become selective and discriminating in their habits.

A listing of media materials that support specific learning objectives within the science program is provided in the *Teacher Resource Manual*. The guidelines that follow will assist teachers in planning instructional activities that involve the use of these and other media resources considered appropriate for use within the science classroom.

- The resource need not be shown in its entirety. Selected portions may more effectively meet student needs.

- Consider viewing audio-visual resources without audio accompaniment, or with only teacher accompaniment.

- Provide students with a prepared question sheet for use while the media is being viewed. This will focus attention on relevant aspects of the topic/issue being investigated.

- Media materials may be viewed more than once. They might be initially viewed in an uninterrupted manner, and then a second time for note-taking or answering questions.

- Plan specific follow-up activities to ensure that students have understood key concepts and ideas related to the investigation.

EVALUATION

Evaluation should be viewed as an ongoing part of the teaching and learning process, providing feedback to students, teachers, and parents/guardians. Major functions served by the process of evaluation include:

- provision of feedback to students relative to individual success in the learning process. Students have difficulty in monitoring and regulating their learning behaviours, and require a great deal of external feedback as to their progress. Feedback and encouragement must be provided on a regular basis
- provision of information to teachers concerning the appropriateness of learning goals and objectives, and the effectiveness of learning strategies and materials that have been used. Such information enables the teacher to modify the program as required with respect to pacing, learning resources, teaching methods or objectives
- provision of information to parents/guardians regarding the student's progress. Where possible, reports to parents/guardians should be interpreted through an interview so that the implications of the evaluation are understood. While useful in communicating student progress to parents, the interview is also valuable in identifying individual needs that may be addressed through program planning.

Evaluation should serve diagnostic purposes in identifying student strengths and weaknesses, as well as summative needs in measuring overall growth.* **Because evaluation is an integral part of all aspects of the instructional process, information used in the evaluation of a student should be gathered from a variety of sources using a variety of methods.**

STRATEGIES FOR EFFECTIVE EVALUATION

Evaluation may, in the past, have been the process by which some students within the program were identified as "failures". These students will go to extreme measures to avoid being "tested" again. Absence from examinations; feigning an "I don't care anyway" attitude; or not giving their best effort so that the anticipated failure can be combatted with "I didn't try my best", are all common behaviours. It is therefore important to provide variation in assessment procedures that are used so as to draw upon students' strengths and provide for their success in the evaluation process. While paper-and-pencil tests may be an effective way of evaluating some learning outcomes, an effective system of evaluation should include use of a variety of sources of information, including:

- observation of attitudes and performance
- oral and written presentations describing the outcomes of investigation
- personal interviews with students
- attitude scales
- samples of individual and project work
- feedback from parents
- teacher rating scales/checklists/inventories
- anecdotal records
- self and peer evaluations
- records of previous achievement
- diagnostic tests
- pre-tests and post-tests on specific objectives, topics or units
- suitable standardized examinations.

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*A variety of diagnostic instruments are available through Alberta Education, Learning Resources Distributing Centre.

The suggestions and strategies provided here are intended to serve as guidelines to the teacher in developing a system of evaluation that will improve both student learning and the quality of the science program offered to students.

- Provide opportunities for students to "demonstrate" their understanding of concepts and skills studied through discussion, project work and group activities.

- Observe students in small group situations in order to gain insights as to their:

  - level of independence with the work
  - method of attacking problems/ability to conduct investigations
  - ability to apply concepts and skills to new situations.

- Conduct interviews with students following completion of an assignment/project in order to evaluate understanding of concepts/processes/applications. Such interviews may also suggest more effective ways of structuring future assignments.

- Emphasize the "synthesis" of a variety of knowledge and process objectives, rather than recall or recognition of isolated facts. Provide students with informal situations where they can demonstrate their application of knowledge, skills and problem-solving strategies in simple investigations.

- Plan for student success in the evaluation process. Over-dependence on paper-and-pencil techniques often does not permit students with learning difficulties to do well. When planning formal evaluation procedures, caution should be exercised with regard to the overuse of:

  - multiple choice exams
  - difficult wording and vocabulary
  - simple recall of information without understanding and application.

  Providing a taped version of tests for students who experience difficulty with reading is often a useful strategy. Some students may also benefit if allowed to explain answers on tape, or to another trustworthy individual.

- Provide encouragement by asking questions and making statements that will prompt students to evaluate their work and learning. These techniques will encourage students to be less dependent on external rewards and more responsible for their own learning. Some examples might include:

  "You did a good job of ____(be specific)________."
  "What steps did you find most difficult?"
  "How could you improve your work in this question?"

- Provide opportunities for the use of self and peer evaluation techniques. Students should realize that ongoing self-evaluation, as well as external evaluation, is a positive developmental process. Assist students to understand that making mistakes and developing the ability to identify and correct errors are part of the growth process and that mistakes need not be embarrassments.

- Provide adequate time for students to complete their work. Students often do not do their best under time pressure.

- Give students advance notice and a study guide to highlight the areas that need review when planning formal evaluation (e.g., a quiz or a test). Students rarely do their best when caught off guard by "surprise" quizzes.

The *Teacher Resource Manual* contains additional guides and checklists for assessing and evaluating students' performance and achievement in the science program.

SCOPE AND SEQUENCE

The scope and sequence chart provided on the following pages outlines the concepts, skills and attitudes that are addressed throughout Science 16 and 26. As students differ in the rate at which they acquire competencies in science, the chart is intended to assist teachers in assessing present levels of student performance, and in diagnosing individual strengths and weaknesses.

In using the scope and sequence, it should be noted that:

- **attitudes and skills are developmental through Science 16 and 26** (i.e., the spiral approach). Students will refine and extend the attitudes and skills developed in Science 16 through more extensive applications in Science 26.

- **concepts developed in the Science 16 program are in most cases discrete from concepts developed in the Science 26 program.** Effort has been made to apportion concepts throughout Science 16 and Science 26 on the basis of their cognitive demand.

- **the attitudes, skills and concepts are interdependent at each grade level, and are not meant to be developed in isolation.** Although some concepts and skills may be mastered more effectively through discrete instruction, this approach is not advocated as a primary focus of instruction. The thematic structure permits the linking of concepts, skills and attitudes.

- most students will continue to use concrete operational thinking, depending upon personal and tangible experience in order to link ideas. **Instruction should generally begin with an operational understanding of ideas at the Science 16 level, and encourage students to extend their thinking to more abstract levels that are cognitively appropriate at the Science 26 level.** (The *Teacher Resource Manuals* for Science 16 and 26 provide for the development of thinking skills through themes that reflect increasing levels of analysis and critical thought.)

Prescribed components of the science program outlined in the scope and sequence chart should be appropriately clustered and applied to progressively difficult and/or age-appropriate situations as students advance through senior high school. Teachers are encouraged to organize for instruction in ways that are consistent with the abilities, needs and interests of students, using relevant sections of the Program of Studies/Presentation of Content (pp. 40-63), thematic units provided in the *Teacher Resource Manual*, locally developed themes, or a combination of approaches.

Teachers are encouraged to examine the Scope and Sequence chart for the Integrated Occupational Junior High School Science Program (Grades 8 and 9). An understanding of the developmental progression of concepts, skills and attitudes occurring in Grade 8 and Grade 9 will facilitate articulation between the junior high and senior high science programs.

LIFE FORMS AND CHANGES

<table>
<tr><th></th><th>SCIENCE 16
SYSTEMS OF THE HUMAN BODY</th><th>SCIENCE 26
PERSONAL HEALTH AND LIFESTYLE</th></tr>
<tr><td>ATTITUDES</td><td colspan="2">Students will be encouraged to:
• display a positive attitude toward the learning of concepts and skills in science
• appreciate the intricate workings and balance within the human body
• appreciate the contributions of science and technology to human health
• value knowledge gained for its usefulness on a personal level
• appreciate the need for informed decision making at both personal and societal levels
• appreciate that ethical dilemmas may arise from the application of scientific research and/or medical technologies
• display responsible attitudes toward personal health through nutrition, exercise, safety and lifestyle.</td></tr>
<tr><td>SKILLS</td><td colspan="2">Students will be expected to demonstrate an ability to:
• collect data related to critical life functions, body systems and lifestyle factors through observation, interview and/or research
• design an experiment, through class discussion, to examine induced variations in the functioning of a body system
• use selected technological processes, instruments and/or products in collecting data about personal health and fitness factors
• analyze and assess personal health, fitness and lifestyle factors by identifying relationships, by considering consequences, and by examining a variety of viewpoints
• infer potential threats to personal health that may be caused by lifestyle factors
• apply the results of investigation to personal situation, identifying appropriate strategies for monitoring and maintaining personal health.</td></tr>
<tr><td>CONCEPTS</td><td>Students will be expected to demonstrate an understanding that:
• the human body is a product of a number of body systems working together to perform critical life functions
• each body system has specific structures that enable it to perform a critical life function
• functional relationships among systems of the human body are critical to life
• medical technology can be used to monitor body conditions and personal health factors
• relationships exist between the diagnosis, prevention and treatment of malfunctions within body systems
• societal issues may arise from the use of technologies in preserving balance among systems of the human body.</td><td>Students will be expected to demonstrate an understanding that:
• personal diet should include minimal amounts of certain foods in order to maintain health
• much of our food, particularly processed food items, contain additives
• drugs, alcohol and tobacco may affect nutritional requirements and cause related disease
• a relationship exists between caloric intake, energy output and body weight
• physical exercise can contribute to cardiovascular and respiratory health
• personal and social factors can have both positive and negative effects on one's health and well-being
• interrelationships exist among lifestyle factors/choices (e.g., diet, exercise, substance use/abuse, stress) and personal health.</td></tr>
</table>

USING MATERIALS AND PRODUCTS

<table>
<tr><th></th><th>SCIENCE 16
CHEMISTRY FOR THE CONSUMER</th><th>SCIENCE 26
MATERIALS WE USE</th></tr>
<tr><td>ATTITUDES</td><td colspan="2">Students will be encouraged to:
• display a positive attitude toward the learning of concepts and skills in science
• value scientific principles and processes for their usefulness in providing explanations of everyday phenomena
• appreciate the usefulness of measurement skills in real life and work-related situations
• appreciate how technology may facilitate the solving of practical problems, and create new problems
• appreciate the usefulness and potential hazards of common household materials
• display a respect for personal safety and the safety of others when handling potentially hazardous materials
• appreciate the contributions of science and technology to the development of a variety of materials and products that we depend upon and use each day.</td></tr>
<tr><td>SKILLS</td><td colspan="2">Students will be expected to demonstrate an ability to:
• conduct experiments that illustrate the properties of familiar substances and materials
• design experiments, through class discussion, that illustrate predictability in the behaviour of substances and materials that are investigated
• effectively use apparatus and equipment when conducting experiments
• make qualitative and quantitative observations when conducting experiments
• identify patterns and relationships in the behaviour of substances and materials, and use this information to explain the application of particular consumer products in everyday situations
• predict heat exchange in practical situations, and use appropriate procedures for protecting living organisms and other materials from excessive heat transfer
• accurately read product labels and consumer reports in order to determine the composition and intended use of familiar household products
• apply appropriate techniques for identifying acids, bases and other hazardous substances
• use safe procedures for handling and storing potentially dangerous substances.</td></tr>
<tr><td>CONCEPTS</td><td>Students will be expected to demonstrate an understanding that:
• the properties of household solutions are different from those of pure substances
• permanent suspensions have useful properties and a variety of applications in the home
• acids and bases have useful properties and a variety of applications in the home
• solubility varies with temperature
• many chemical reactions may require or emit energy in the form of heat
• heat flows from areas of high temperature to areas of lower temperature
• handling, storing and using potentially hazardous chemical products require knowledge and care.</td><td>Students will be expected to demonstrate an understanding that:
• models and other conceptual inventions are useful in explaining the composition and behaviour of matter
• the properties of the materials and products we use are determined by their composition
• materials and products are derived from both natural and synthetic sources
• the properties of materials determine their suitability for particular applications
• our use of natural and synthetic materials affects both environment and resources
• the process of biodegradation reduces the impact of some products on the environment
• technological products and processes develop in response to societal needs, and are often accepted and used before the full extent of benefits/problems resulting from their use can be known.</td></tr>
</table>

TECHNOLOGY AT WORK

<table>
<tr><th></th><th>SCIENCE 16
USING SYSTEMS AND TECHNOLOGIES</th><th>SCIENCE 26
TECHNOLOGY IN TRANSPORTATION</th></tr>
<tr><td>ATTITUDES</td><td colspan="2">Students will be encouraged to:
• display a positive attitude toward the learning of concepts and skills in science
• appreciate that science and technology have application in everyday situations, and may facilitate the solving of practical problems
• develop confidence in personal ability to understand and solve practical problems through the use of science and technology
• display a concern for safety and accept the need for rules and regulations governing the use of particular technologies
• appreciate that ethical dilemmas may arise from the application of scientific research and/or technological developments
• appreciate the relationships among science, technology and society.</td></tr>
<tr><td>SKILLS</td><td colspan="2">Students will be expected to demonstrate an ability to:
• observe and analyze the operation of familiar devices and systems, identifying component parts and scientific principles that are utilized
• prepare systems diagrams that illustrate how component parts and/or subsystems within a technological device work together in accomplishing a task
• test and evaluate the performance of a familiar device by
– identifying basic principles governing its operation and use
– inferring potential malfunctions and appropriate maintenance/repair procedures
– suggesting ways to improve efficiency of design and/or operation
• design and construct a simple technological device or process by
– identifying a relevant need or problem not satisfied by technology
– identifying alternative approaches/designs to deal with the problem
– selecting a design and constructing the device
– testing and troubleshooting the device
• infer how specific technologies have personal application and solve practical problems.</td></tr>
<tr><td>CONCEPTS</td><td>Students will be expected to demonstrate an understanding that:
• technology may facilitate the solving of practical problems through application of scientific knowledge
• basic scientific principles are associated with the functioning of technological devices
• many technological systems consist of combinations of subsystems that work together in accomplishing a particular task
• science can be used to advance technology and technology can be used to advance science
• new and emerging technological products/processes often reflect current needs and wants in society
• products of technology are often used by society before the full extent of benefits/problems resulting from their use can be known.</td><td>Students will be expected to demonstrate an understanding that:
• the automobile is a technological system consisting of a number of subsystems that work together
• basic scientific principles are associated with the functioning of subsystems in an automobile
• simple maintenance procedures contribute to the efficient performance and general safety of an automobile
• the nature of injuries sustained in an automobile accident can be anticipated by considering the effects of first and second collisions
• technology has contributed to safe travel through the development of highway and automobile safety features
• political, ethical and economic perspectives often interact with science and technology, influencing choices and decisions that are made about safe travel.</td></tr>
</table>

UNDERSTANDING OUR ENVIRONMENT

<table>
<tr><th></th><th>SCIENCE 16
CARING FOR ENVIRONMENT AND RESOURCES</th><th>SCIENCE 26
ENERGY AND THE ENVIRONMENT</th></tr>
<tr><td>ATTITUDES</td><td colspan="2">Students will be encouraged to:
● display a positive attitude toward the learning of concepts and skills in science
● appreciate the fragility of the biosphere
● appreciate the interdependence of self with other living forms and the environment
● appreciate that environmental issues involve significant relationships among science, technology and society
● realize our inability to anticipate the environmental effects of human activities
● appreciate that the collective action of individuals can have significant impact
● develop a sense of personal responsibility in relation to environmental issues.</td></tr>
<tr><td>SKILLS</td><td colspan="2">Students will be expected to demonstrate an ability to:
● identify an environmental issue related to the local use of natural resources
● gather information related to the issue through observation, interview and/or research
● design an investigation, through class discussion, that illustrates how particular practices or products are related to the issue and influence environmental quality
● analyze and assess information by identifying patterns and relationships, by judging the reliability/validity of information gathered and by considering consequences
● communicate the results of investigation verbally, through the use of models and diagrams, and/or through written expression
● take an informed position on the issue, identifying strategies that may be used to deal with the situation.</td></tr>
<tr><td>CONCEPTS</td><td>Students will be expected to demonstrate an understanding that:
● the biosphere is a thin layer on the surface of the earth, able to support life
● a continuous supply of solar energy is essential to life
● life depends upon recycling processes
● living organisms interact with each other and with the physical environment
● individuals and society influence the quality of the environment
● developments in science and technology may have unforeseen consequences on society and the environment
● individuals and society can become involved in the resolution of ecological problems that arise.</td><td>Students will be expected to demonstrate an understanding that:
● different forms of energy are used at home and in work-related situations
● there are renewable and non-renewable sources of energy
● energy systems have input, conversion and output components
● the total energy of a system is conserved
● energy efficiency ratings describe the portion of input energy that is converted to useful energy
● consumption of electrical energy in the home can be analyzed and monitored
● energy conservation involves the interaction of economic, political and ethical perspectives with science and technology.</td></tr>
</table>

PROGRAM OF STUDIES/PRESENTATION OF CONTENT

The Program of Studies/Presentation of Content outlines the concepts, skills and attitudes prescribed for Science 26. Learning objectives have been clustered into four themes that provide situational and concrete learning experiences:

- Personal Health and Lifestyle
- Materials We Use
- Technology in Transportation
- Energy and the Environment.

Shaded statements contained in the Program of Studies (Column One) enable the reader to readily identify those portions of the program that are prescribed.

The advice and direction offered throughout Columns Two, Three and Four is not prescriptive, and is offered only as a service to teachers. Column Two, Related Life Skills, establishes an immediate need or use for each concept/skill being studied and suggests ways of planning relevant learning experiences. Further suggestions for relating science competencies to applications in occupational courses and other academic disciplines are provided in Column Three, Related Applications Across the Curriculum. The references provided in this column will facilitate curricular integration by establishing a base for cooperative planning among other subject areas/teachers in the program. A variety of strategies useful in addressing developmental characteristics and learning styles of the student are provided in Column Four, Suggested Strategies/Activities. Teachers are encouraged to use the advice and direction offered throughout Columns Two, Three and Four in conjunction with suggestions provided in the *Teacher Resource Manual* when planning thematic units of instruction that address learning objectives identified in the Program of Studies (Column One).

Prescribed learning objectives outlined in the Program of Studies should be appropriately clustered and applied to progressively difficult and/or age-appropriate situations as students advance through senior high school. Teachers are encouraged to organize for instruction in ways that are consistent with the abilities, needs and interests of students, using relevant section of the Program of Studies/Presentation of Content, thematic units provided in the *Teacher Resource Manual*, locally developed themes, or a combination of approaches.

SCIENCE 26

PERSONAL HEALTH AND LIFESTYLE

OVERVIEW:

This theme will assist students to develop strategies for acquiring and maintaining healthful lifestyles. Students will investigate the effects of nutrition and exercise on personal health, and identify other factors in their personal lives that may promote/hinder the efficient functioning of body systems. A number of technological and societal elements influence our choice of foods, use of leisure time, and other decisions made on a daily basis. Students will develop an understanding of the implications of various technological and societal factors for health and fitness, and will assess the appropriateness of their own decisions in relation to health and lifestyle.

A major emphasis will be placed on developing a process for considering alternatives and making informed choices in everyday situations affecting personal health. Students will apply previously developed knowledge of human body systems (see Science 16: Systems of the Human Body) throughout this theme as they consider the effects of various lifestyle factors on biological processes. Learning objectives interrelate with investigations performed in a subsequent theme, Energy and the Environment, and will assist students to develop an understanding of how various energy alternatives and environmental issues have impact upon personal health or the health of others in society.

ATTITUDES:

Students will be encouraged to:

- display a positive attitude toward the learning of concepts and skills in science by
  - showing interest and curiosity through willingness to ask questions, share observations and ideas, and seek answers
  - performing investigations and completing assignments independently and in cooperation with others
- appreciate the intricate workings and balance within the human body
- appreciate the contributions of science and technology to human health
- value knowledge gained for its usefulness on a personal level
- appreciate the need for informed decision making at both personal and societal levels
- appreciate that ethical dilemmas may arise from the application of scientific research and/or medical technologies
- display responsible attitudes toward personal health through nutrition, exercise, safety and lifestyle.

LEARNING OBJECTIVES

SKILLS:

DEMONSTRATES ABILITY TO USE THE SKILLS AND PROCESSES OF SCIENCE TO MONITOR AND ASSESS THE EFFECTS OF VARIOUS LIFESTYLE FACTORS AND CHOICES ON PERSONAL HEALTH.

- Collects data related to critical life functions, body systems and lifestyle factors through observation, interview and/or research.
- Designs an experiment, through class discussion, to examine induced variations in the functioning of a body system.
- Uses selected technological processes, instruments and/or products in collecting data about personal health and fitness factors.
- Analyzes and assesses personal health, fitness and lifestyle factors by identifying relationships, by considering consequences, and by examining a variety of perspectives.
- Applies the results of investigation to personal situation, identifying appropriate strategies for monitoring and maintaining personal health.

CONCEPTS:

DEMONSTRATES AN UNDERSTANDING THAT PERSONAL DIET SHOULD INCLUDE MINIMAL AMOUNTS OF CERTAIN FOODS IN ORDER TO MAINTAIN HEALTH.

- Describes the function of nutrients (i.e., carbohydrates, fats, proteins, vitamins, minerals) in the human body.
- Identifies foods/food groups that:
  - are a common source of major nutrients
  - add fibre content to diet.
- Cites examples of good nutrition as defined in the Canada Food Guide.
- Explains how diets that include excessive amounts of certain foods (e.g., diets high in cholesterol, fat, salt, sugar) may influence personal health.

DEMONSTRATES AN UNDERSTANDING THAT MUCH OF OUR FOOD, PARTICULARLY PROCESSED FOOD ITEMS, CONTAIN ADDITIVES.

- Identifies and describes the functions of additives present in familiar processed foods.
- Outlines Canada's labelling laws regarding additive listing.
- Interprets label information on familiar processed foods, distinguishing between nutritional and non-nutritional ingredients.

Related Life Skills

Recognizes appropriate strategies for monitoring vital signs and other indicators of health and fitness. Assesses personal health in relation to:

- blood pressure
- body mass index
- body temperature
- diet
- endurance
- flexibility
- lung capacity
- pulse rate
- strength.

Recognizes technological instruments/processes that are used to monitor critical life functions:

- blood-pressure gauge
- electrocardiogram
- endoscope
- microscope
- stethoscope
- thermometer
- x-rays/scanners.

Plans personal diet by considering:

- nutritional requirements
- calorie requirements
- food preferences
- lifestyle
- financial resources.

Recognizes the nutritional value and calories present in frequently eaten fast foods:

- hamburger and fries
- fried chicken
- pizza
- soft drinks and chocolate bars.

Recognizes the inherent dangers of:

- "crash" diets
- "fad" diets
- packaged meal supplements.

Recognizes symptoms, causes and treatments for severe eating disorders:

- anorexia
- bulemia.

Reads product labels before purchasing food products. Identifies:

- ingredients that have nutritional value
- additives/supplements that have been used to enrich, enhance or preserve the product.

Related Applications Across the Curriculum

English

Uses a variety of skills to increase comprehension when gathering and assessing information:

- identifies key concepts
- discards irrelevant information
- identifies cause and effect relationships
- makes inferences and predictions
- draws conclusions
- summarizes.

Demonstrates ability to follow directions when conducting an investigation:

- follows instructions exactly and in sequence
- interprets verbal instructions
- interprets written text that provides directions
- interprets tables, symbols, charts and graphs in order to follow instructions.

Demonstrates ability to assess, generalize and identify practical applications of the results of an investigation through group discussion:

- distinguishes between fact, fiction and opinion
- recognizes that an issue can have many sides
- expresses a personal opinion
- respects the opinions of others.

Mathematics

Uses appropriate units/tools/procedures when measuring:

- distance
- capacity
- time
- temperature.

Applies skills involving measurement, number operations and ratio/proportion when monitoring personal health:

- height/weight
- caloric intake
- heart rate
- fitness level.

Gathers and interprets statistical data related to personal health and lifestyle factors:

- reads/interprets information provided in tables/charts/graphs
- interprets measures of central tendency
- interprets measures of probability.

Analyzes health statistics, detecting biases/inaccuracies.

Suggested Strategies/Activities

Select activities that will encourage students to develop a personal strategy for acquiring and maintaining a healthy lifestyle. Provide opportunity for students to:

- examine their own practices as they relate to nutrition and exercise
- monitor the effect of these practices on the functioning of major body systems
- examine a variety of viewpoints/alternatives with respect to health issues
- assess daily choices/decisions that are made in areas that affect personal health.

Organize classroom activities in ways that encourage students to be active participants in thinking and learning. Provide opportunities for:

- total group involvement in listening/viewing and interacting
- cooperative group work in pairs or small groups
- individual student work.

The sequence of activities outlined below may be useful in fostering active student involvement throughout thematic investigations.

- Involve students in a situation that stimulates them to ask questions and identify problems.
- Record questions/problems on the blackboard/overhead.
- Encourage students to suggest ideas related to the questions asked.
- Assist students to design a research proposal, describing:
  - questions/problems they will answer
  - how and where they will find their information
  - how long it will take them
  - what equipment they will need.
- Permit students to conduct research on their problem using their suggested activities. This may include:
  - observation/experiment
  - consulting books
  - interviewing knowledgeable people.
- Provide opportunity for students to report their findings to the class. Encourage students to comment on:
  - whether or not they really found the answer they were looking for
  - possible alternative answers or explanations
  - further investigations that might follow.

Monitor participation, attitudinal development and ability to apply appropriate skills throughout thematic investigations by using a variety of assessment techniques. Sample checklists, inventories and interview guides are suggested in the *Teacher Resource Manual*: Assessment/Evaluation.

LEARNING OBJECTIVES

CONCEPTS (continued):

DEMONSTRATES AN UNDERSTANDING THAT DRUGS, ALCOHOL AND TOBACCO MAY AFFECT NUTRITIONAL REQUIREMENTS AND CAUSE RELATED DISEASE.

- Describes how drugs, alcohol and tobacco can affect appetite, nutritional requirements and the functioning of body systems.
- Gives examples of specific diseases related to drug, alcohol and tobacco abuse.

DEMONSTRATES AN UNDERSTANDING OF THE RELATIONSHIP THAT EXISTS BETWEEN CALORIC INTAKE, ENERGY OUTPUT AND BODY WEIGHT.

- Compares daily caloric intake to calorie requirements suggested by personal data (e.g., body mass index, basal metabolic rate, activity level).
- Describes strategies for maintaining or increasing/decreasing present body weight through caloric intake and energy output.

DEMONSTRATES AN UNDERSTANDING THAT PHYSICAL ACTIVITY CAN CONTRIBUTE TO CARDIOVASCULAR AND RESPIRATORY HEALTH.

- Explains how level of fitness (e.g., endurance, strength, flexibility) is influenced by physical activity.
- Identifies relationships between level of fitness and the functioning of cardiovascular/respiratory systems.

DEMONSTRATES AN UNDERSTANDING THAT PERSONAL AND SOCIAL FACTORS CAN HAVE BOTH POSITIVE AND NEGATIVE EFFECTS ON ONE'S HEALTH AND WELL-BEING.

- Identifies personal and social factors that influence attitudes and behaviours (e.g., needs, values, emotions, peers).
- Explains how particular attitudes/behaviours may involve varying degrees of risk to personal health and well-being.

DEMONSTRATES AN UNDERSTANDING THAT INTER-RELATIONSHIPS EXIST AMONG LIFESTYLE FACTORS/CHOICES AND PERSONAL HEALTH.

- Identifies lifestyle factors and choices that affect personal health (e.g., diet, physical activity, substance use/abuse, stress).
- Infers the consequences of inappropriate nutrition, level of activity and weight on personal health (e.g., minor deficiencies/imbalances, life threatening conditions).
- Describes a personal action plan designed to improve one or more aspects of personal health and lifestyle.

Related Life Skills

Understands possible results of the repeated use of prescription/non-prescription drugs:

- decline in the drug's effectiveness
- need for increased dosage
- allergic or other reactions
- physical dependence and addiction.

Reads label information provided on drugs. Interprets the meaning of directions and dosages.

Recognizes dangers associated with the use/misuse of alcohol, drugs and tobacco:

- nutrition/health/disease
- physical/psychological addiction
- accident/injury
- social/legal problems
- financial deprivation.

Practises weight management by:

- balancing caloric intake with caloric requirements
- maintaining appropriate levels of activity and exercise
- joining a health/fitness club.

Recognizes the benefits of incorporating physical fitness into one's lifestyle:

- increased endurance, flexibility and strength
- reduced risk of injuries
- reduced neuromuscular tension.

Formulates personal strategies for maintaining/improving personal fitness level:

- exercise routines at school or work
- appropriate recreational/leisure time activities
- specific sport/fitness programs.

Recognizes societal factors that may influence diet and recreational activities:

- fashion, style and trends
- advertising and media
- peer relationships.

Recognizes lifestyle factors and choices that can influence personal health:

- eating habits
- type of work
- recreational/leisure time activities.

Related Applications Across the Curriculum

Social Studies

Uses knowledge of community institutions and services in gaining access to medical assistance and advice:

- medical clinics, hospitals
- family, career and personal counselling agencies.

Synthesizes and applies knowledge gained from studying current affairs to express opinions about health issues:

- cost of maintaining health care systems
- regulations designed to control pollution and/or other environmental concerns.

Uses an appropriate decision-making model to identify personal and societal endeavours designed to promote health and fitness.

Occupational Courses

Appreciates the effects that personal health and lifestyle have on job selection, acquisition, performance and retention.

Identifies occupational opportunities that exist in areas related to health and fitness. Considers related entrepreneurial opportunities.

Follows "on-the-job" safety and sanitary standards and appreciates their importance in maintaining personal health and the health of co-workers.

Interprets "hazardous product" and "safety" symbols that relate to occupational areas that are studied.

CALM

Monitors personal level of health and fitness.

Identifies appropriate strategies for acquiring and maintaining a healthful lifestyle.

Understands the effects of alcohol/tobacco/drugs on the body, and displays a responsible attitude toward their use.

Suggested Strategies/Activities

Assist students to develop the required knowledge base by providing a variety of "input" activities (e.g., periodicals, pamphlets, resource people, films, videos). Organize information that is gathered by using strategies suggested in the *Teacher Resource Manual*: Communication Skills (e.g., semantic webs, skeletal outlines, concept circles).

Provide opportunities for students to investigate various technological products and processes used in the field of medicine, and to consider:

- their contributions in monitoring and/or maintaining personal health
- ethical dilemmas that may arise from their application in society.

When examining health issues, guide students through the process of analysis and critical thought by using strategies provided in the *Teacher Resource Manual*: Communication Skills, "Using Critical Thinking Skills".

e.g.,
- PMI (Plus-Minus-Interesting)
- CAF (Consider All Factors)
- C and S (Consequences and Sequels).

Community Partnerships:

- Invite a nutritionist to discuss the facts, fads and fallacies of eating habits and diets.
- Invite a doctor (or nurse) to discuss the relationship between nutrition, fitness and lifestyle.
- Invite medical experts/the police/social workers/rehabilitated clients to discuss the misuse and abuse of alcohol, drugs and tobacco.
- Invite a local fitness expert to discuss:
  - personal fitness measures
  - strategies for improving fitness.
- Obtain health/fitness pamphlets and brochures from a local doctor, the school nurse, or community agency responsible for health.
- Invite the school nurse to demonstrate appropriate techniques for monitoring personal health factors (e.g., blood pressure, pulse rate).
- Invite a pharmacist to discuss:
  - prescription/non-prescription drugs
  - their effects on the body
  - the interpretation of label directions/dosages
  - drug safety in the home.
- Invite a representative of Consumer and Corporate Affairs to discuss Canada's food labelling laws.
- Visit a local health/fitness centre and investigate conditioning principles that govern the use of exercise bicycles/rowing machines/aerobic routines.

SCIENCE 26

MATERIALS WE USE

OVERVIEW:

Activities will focus attention on the materials and products used by students in their everyday lives. By carrying out a series of controlled experiments, students will investigate the composition and properties of a variety of natural and synthetic materials used at home and in work-related situations. Students will be expected to develop strategies for:

- safe handling of potentially dangerous materials and situations encountered within the home and work environments
- selecting consumer products on the basis of their composition, properties and suitability for particular applications.

A major emphasis will be placed on developing an understanding of the processes used in conducting scientific inquiry. Students will apply previously developed knowledge of chemical substances and reactions (see Science 16: Chemistry for the Consumer) throughout this theme as they investigate the properties of familiar materials and products. Learning objectives interrelate with investigations performed in a subsequent theme, Technology in Transportation, and will enable students to extend their understanding of the role of science and technology in developing new products and processes, and the ways in which products of technology change many aspects of society.

ATTITUDES:

Students will be encouraged to:

- display a positive attitude toward the learning of concepts and skills in science by
  - showing interest and curiosity through willingness to ask questions, share observations and ideas, and seek answers
  - performing investigations and completing assignments independently and in cooperation with others
- value scientific principles and processes for their usefulness in providing an understanding of everyday phenomena
- appreciate the usefulness of measurement skills in "real life" and work-related situations
- appreciate how technology may facilitate the solving of practical problems, and create new problems
- appreciate both the usefulness and potential hazards of common household materials
- display a respect for personal safety and the safety of others when handling potentially hazardous materials
- appreciate the contributions of science and technology to the development of a variety of materials and products that we depend upon and use each day.

LEARNING OBJECTIVES

SKILLS:

DEMONSTRATES ABILITY TO USE THE SKILLS AND PROCESSES OF SCIENCE TO INVESTIGATE THE COMPOSITION AND PROPERTIES OF FAMILIAR MATERIALS.

- Conducts experiments that illustrate the properties of familiar natural and synthetic materials.
- Designs experiments, through class discussion, that illustrate:
  - corrosive reactions among familiar substances/products
  - the insulation values of familiar fibres
  - the biodegradability of familiar materials/products.
- Effectively uses apparatus and equipment when conducting experiments.
- Makes qualitative and quantitative observations when conducting experiments.
- Identifies patterns and relationships in the behaviour of natural and synthetic materials, and uses this information to explain applications of particular consumer products in everyday situations.
- Predicts heat exchange in practical situations, and uses appropriate procedures for protecting living organisms and other materials from excessive heat transfer.
- Accurately reads product labels and consumer reports in order to determine the composition and intended use of familiar household products.
- Applies appropriate techniques for identifying acids, bases and other hazardous materials.
- Uses safe procedures for handling and storing potentially dangerous substances.

CONCEPTS:

DEMONSTRATES AN UNDERSTANDING THAT MODELS AND OTHER CONCEPTUAL INVENTIONS ARE USEFUL IN EXPLAINING THE COMPOSITION AND BEHAVIOUR OF MATTER.

- Illustrates, through the use of models, how atoms and molecules represent structural units of matter.
- Relates the behaviour of atoms and molecules in familiar substances to the Kinetic Molecular Theory.
- Interprets symbols/formulas that represent the most common elements and simple compounds familiar to the student.

DEMONSTRATES AN UNDERSTANDING THAT THE PROPERTIES OF THE MATERIALS AND PRODUCTS WE USE ARE DETERMINED BY THEIR COMPOSITION.

- Describes the composition of two or more familiar materials in terms of their elements, atoms, molecules and compounds.
- Relates the properties of two or more familiar materials to their composition.

Related Life Skills

Uses knowledge of the Kinetic Molecular Theory to interpret/explain the behaviour of familiar materials:

- expansion/contraction
- freezing/melting
- evaporation/condensation.

Recognizes the properties/uses of familiar materials found in the home:

- wood/paper
- concrete/brick
- ceramics/glass
- fabrics/textiles
- metals/alloys
- plastics/polymers.

Identifies factors contributing to the frequent use of particular construction materials in the local community:

- availability/supply of materials
- design/function of structures
- cost factors
- climate/soil conditions.

Selects construction materials that are appropriate to a task by considering:

- durability/strength
- resistance to weathering/corrosion
- weight
- workability/flexibility
- repairability.

Assesses competing consumer products by considering the properties of materials from which the products are made. Chooses between:

- cotton and polyester
- paper and plastic
- hardwood and softwood
- wrought iron and cast iron
- iron and steel
- plastic and kevlar.

Recognizes appropriate care strategies for metals often used in the home:

- jewelry metals (e.g., gold, silver)
- cooking/baking utensils (e.g., copper, aluminum)
- metals used for home decoration (e.g., brass, silver).

Identifies appropriate procedures for controlling the rusting/corrosion of household materials:

- galvanization
- use of waxes/paints/lubricants.

Related Applications Across the Curriculum

English

Uses appropriate inquiry strategies and skills when investigating the properties of materials:

- gathers information from a variety of sources
- evaluates information and the information source
- uses a strategy to organize information
- reports information in oral, written or visual form.

Formulates questions about scientific investigation through group discussions:

- uses a variety of questioning techniques
- probes for further information.

Recognizes that authors use a variety of structural techniques to develop a story, poem or play. Identifies structural techniques used by the author to develop:

- setting
- characters
- mood
- plot.

Mathematics

Uses appropriate units/tools/procedures for estimating and measuring:

- mass
- capacity
- time
- temperature.

Applies ratio and proportion skills when:

- describing the composition of chemical mixtures and solutions
- determining appropriate ingredients for mixtures and solutions
- determining the density of familiar materials.

Applies appropriate statistical skills when collecting, organizing, analyzing and communicating data obtained through experimentation:

- collects and organizes data using tally sheets and frequency tables
- displays data in the form of tables/charts and bar/line/picture/circle graphs
- determines appropriate measures of central tendency (e.g., mean, median, mode, range).

Suggested Strategies/Activities

Emphasize active inquiry and involvement in the learning process by encouraging students to:

- observe, think about and discuss the natural and synthetic materials they use in everyday activities
- observe, predict and attempt to explain unusual properties/discrepant events where the materials they use exhibit unique characteristics
- engage in dialogue and debate so they may become aware of other explanations and ways of thinking about the phenomena observed.

Learning objectives relate to a broad range of familiar materials/products and, depending upon student interests and abilities, can be developed by:

- investigating one natural material and one synthetic material
- studying two or more materials from each category
- selecting activities that relate to a variety of familiar materials.

Assist students to prepare for what they will learn, and to organize and integrate new concepts/relationships by using advance organizers and conceptual overviews that are provided in the *Teacher Resource Manual*: Communication Skills.

e.g.,
- semantic webs
- skeletal outlines
- concept circles.

Model the use of strategies and skills appropriate to conducting experiments by "talking through" an investigation. Illustrate how discrete skills are used at various times throughout the experiment. Ask probing questions that will focus attention on elements of the situation that might be otherwise overlooked. By making students aware of appropriate thought processes, they will be better able to:

- relate specific skills used in an experiment to an overall strategy
- discuss the process they use with their peers and the teacher
- monitor and evaluate their own progress through an investigation.

Additional suggestions for developing inquiry skills are provided in the *Teacher Resource Manual*: The Nature of Science.

CONCEPTS (continued):

DEMONSTRATES AN UNDERSTANDING THAT MATERIALS AND PRODUCTS ARE DERIVED FROM BOTH NATURAL AND SYNTHETIC SOURCES.

- Identifies products in everyday use that are derived from both natural and synthetic sources.
- Describes the industrial process involved in the manufacture of at least one natural product and at least one synthetic product.

DEMONSTRATES AN UNDERSTANDING THAT THE PROPERTIES OF MATERIALS DETERMINE THEIR SUITABILITY FOR PARTICULAR APPLICATIONS.

- Describes the properties of familiar materials used at home and in work-related situations (e.g., metals/alloys, wood/paper products, fibres/fabrics, plastics/polymers, composite materials).
- Cites the advantages and/or disadvantages of familiar materials, relative to their suitability for particular applications.

DEMONSTRATES AN UNDERSTANDING THAT OUR USE OF NATURAL AND SYNTHETIC MATERIALS AFFECTS BOTH ENVIRONMENT AND RESOURCES.

- Cites advantages and/or disadvantages associated with the use of a familiar natural and synthetic product, relative to:
  - the industrial processing of resources to form the product
  - the effect of the product's disposal on the environment.
- Infers the need for biodegradable products and recyclable products.

DEMONSTRATES AN UNDERSTANDING THAT THE PROCESS OF BIODEGRADATION REDUCES THE IMPACT OF SOME PRODUCTS ON THE ENVIRONMENT.

- Explains the process of biodegradation.
- Describes how non-biodegradable materials may harm the environment.
- Distinguishes between familiar materials/products that are biodegradable and non-biodegradable.

DEMONSTRATES AN UNDERSTANDING THAT TECHNOLOGICAL PRODUCTS AND PROCESSES DEVELOP IN RESPONSE TO SOCIETAL NEEDS, AND ARE OFTEN ACCEPTED AND USED BEFORE THE FULL EXTENT OF BENEFITS/PROBLEMS RESULTING FROM THEIR USE CAN BE KNOWN.

- Describes a situation in which science and technology have assisted in solving a practical problem through the development of a new material.
- Identifies a current issue/problem in society arising from the application of a technological product or process.

Distinguishes between natural and synthetic fibres. Selects fibres/fabrics appropriate to a particular application after considering factors such as:

- strength/durability
- insulation qualities
- laundry/cleaning instructions
- drying time
- resistance to wrinkles
- reaction with bleach/dye
- shrinkage
- combustibility.

Interprets the meaning of symbols used on clothing care labels.

Recognizes the impact of recently developed materials (e.g., plastics, polymers, composites) on:

- health and safety (e.g., fibre optics, prosthetic limbs, safety glass)
- sport and recreation (e.g., protective clothing, sporting equipment)
- transportation (e.g., steel-belted tires, airplane parts).

Understands the importance of biodegradable materials/products in protecting the environment. Uses biodegradable products when appropriate:

- paper products rather than plastic products
- natural fibres rather than synthetic fibres
- organic cleaning agents rather than chemical cleaners
- peat moss/manure rather than chemical fertilizers.

Recognizes that there may be long-term burdens associated with the use of some materials:

- depletion of natural resources
- disposal of non-biodegradable waste materials.

Appreciates the importance of recycling materials and products. Uses existing recycling centres on a regular basis (e.g., bottle depot, newspaper collection centre, scrap metal dealer), and supports other recycling initiatives taken in the local community. Chooses to buy recycled materials and products when possible.

Related Applications Across the Curriculum

Social Studies

Identifies industries and businesses in the local community that utilize natural and synthetic materials.

Recognizes current health and safety concerns related to the use of certain products in the local community:

- personal health and safety in relation to the use of particular household and industrial products
- the effects of chemical pollution and waste disposal on personal health and the environment.

Uses problem-solving and decision-making skills in developing strategies for dealing with local and global issues arising from the disposal of non-biodegradable materials.

Investigates local bylaws that control the transportation, storage and disposal of potentially hazardous materials.

Occupational Courses

Applies knowledge of the properties and applications of familiar materials in work-related situations:

- fibres and fabrics
- wood and paper products
- metals and alloys
- plastics and polymers
- composite materials.

Identifies new materials and products that have been developed by science and technology to solve practical problems in the workplace.

Recognizes how natural and synthetic materials are used in producing familiar products:

- cooking oils
- fabrics
- fertilizers.

Distinguishes between biodegradable and non-biodegradable materials commonly used in the home, school and workplace. Identifies appropriate procedures for disposing of waste materials.

Follows safe handling and storage practices when using potentially hazardous materials:

- reads/interprets safety symbols and directions provided on product labels
- understands and uses the Workplace Hazardous Materials Information System (WHMIS).

Recognizes the detrimental effects of corrosion. Identifies strategies that inhibit/control the corrosion of tools and equipment.

Suggested Strategies/Activities

Devise an experiment to test a manufacturer's claim on a familiar consumer product. Use the results of investigation to:

- assess the validity of the manufacturer's claim regarding the product's properties and applications
- develop a strategy for selecting consumer products on the basis of their proven properties and suitability for particular applications.

Activities in this theme provide much opportunity for enhancing interpersonal skills among students within the classroom. Experiments can be performed in group settings through the use of group problem solving. As interactive/communicative problems become evident, use a problem-solving approach to generate:

- reasons for the difficulty
- strategies to avoid the problem next time.

A framework for social problem solving is provided in the *Teacher Resource Manual:* Interpersonal Skills and Cooperative Learning.

Encourage students to develop appropriate safety attitudes and procedures by:

- viewing slide sets/videos/cartoons that demonstrate safe laboratory procedures
- interpreting directions/warning labels that accompany potentially dangerous materials
- discussing the recovery techniques for errors in handling potentially dangerous materials.

Community Partnerships:

- Plan a field trip into the local community and observe:
    - the kinds of materials that are used in local buildings/structures
    - instances where materials and products have weathered/corroded.
- Visit local industry and observe the technological processes involved in producing various materials/products.
- Visit a local fabric store and gather information about the properties of familiar natural/synthetic fabrics.
- Invite a representative from a local dry-cleaning firm to discuss appropriate care strategies for familiar fabrics.
- Visit a recycling centre. Investigate procedures that are used in sorting and recycling solid wastes.
- Visit local stores and gather information provided on the labels of familiar materials/products (e.g., product composition, directions for use, recovery techniques for errors in handling, care strategies).

SCIENCE 26

TECHNOLOGY IN TRANSPORTATION

OVERVIEW:

The automobile is one of the most commonly used technologies in today's society. Its use may be the first major responsibility in many students' lives. Activities within this theme will enable students to develop an understanding of:

- scientific principles governing the operation of an automobile
- appropriate strategies for maintaining a safe automobile
- issues related to automobile safety, driver protection and the environment.

A major emphasis will be placed on developing a process for solving practical problems of a technological nature through hands-on experience. Students will apply previously developed knowledge of technological systems (see Science 16: Using Systems and Technologies) throughout this theme as they investigate the functioning of different subsystems in an automobile. Learning objectives interrelate with investigations performed in a prior theme, Materials We Use, and will enable students to extend their understanding of the role of science and technology in developing new products and processes, and the ways in which products of technology change many aspects of society. Learning objectives also interrelate with a subsequent theme, Energy and the Environment, and will contribute to an understanding of current issues involving our use of energy and the environment.

ATTITUDES:

Students will be encouraged to:

- display a positive attitude toward the learning of concepts and skills in science by:
  - showing interest and curiosity through willingness to ask questions, share observations and ideas, and seek answers
  - performing investigations and completing assignments independently and in cooperation with others
- appreciate that science and technology have application in many everyday situations, and may facilitate the solving of practical problems
- develop confidence in personal ability to understand and solve practical problems through the use of science and technology
- display a concern for safety and accept the need for rules and regulations governing the use of particular technologies
- appreciate that ethical dilemmas may arise from the application of scientific research and/or technological developments
- appreciate the relationships among science, technology and society.

LEARNING OBJECTIVES

SKILLS:

DEMONSTRATES ABILITY TO USE THE SKILLS OF SCIENCE AND A PROBLEM-SOLVING STRATEGY TO INVESTIGATE AUTOMOBILE TECHNOLOGY AND SOLVE RELATED PROBLEMS.

- Observes and analyzes the operation of one or more subsystems in an automobile (e.g., electrical system, cooling system, fuel system, lubrication system, tire/braking system), identifying component parts and scientific principles that are utilized.
- Prepares systems diagrams that illustrate how component parts and/or subsystems within an automobile work together in accomplishing a task.
- Tests and evaluates the performance of one or more technological devices/systems in an automobile:
  - identifies basic principals governing its/their operation and use
  - infers potential malfunctions and appropriate maintenance/repair procedures
  - suggests ways to improve efficiency of design and/or operation.
- Uses a problem-solving strategy to design and construct a simple safety technology:
  - identifies a safety problem
  - considers alternative approaches/designs to deal with the problem
  - selects a design and constructs the device
  - tests and troubleshoots the device
  - evaluates the product and the process.
- Infers how specific technologies related to the automobile have personal application and solve practical problems.

CONCEPTS:

DEMONSTRATES AN UNDERSTANDING THAT THE AUTOMOBILE IS A TECHNOLOGICAL SYSTEM CONSISTING OF A NUMBER OF SUBSYSTEMS WORKING TOGETHER.

- Describes the basic function of different subsystems in an automobile, including the electrical system, cooling system, fuel system, lubrication system and tire/braking system.
- Illustrates how subsystems in an automobile work together by tracing energy flow/transformation through two or more subsystems.

DEMONSTRATES AN UNDERSTANDING THAT BASIC SCIENTIFIC PRINCIPLES ARE ASSOCIATED WITH THE FUNCTIONING OF SUBSYSTEMS IN AN AUTOMOBILE.

- Explains the operation of one or more subsystems in an automobile, citing relevant scientific facts, laws and theories.

Related Life Skills

Recognizes the importance of using lubricants to reduce friction between moving parts of an automobile:

- engine oil
- semi-solid lubricants (e.g., grease).

Follows appropriate strategies to ensure that personal/family automobile is properly lubricated:

- checks level of engine oil on a regular basis
- establishes a regular maintenance schedule for changing oil/lubricating other moving parts.

Understands the function of a vehicle's cooling system in dispersing engine heat produced by combustion and friction. Recognizes that the engine may overheat and seize if the cooling system is not functioning efficiently.

Monitors the cooling system of personal/family car by:

- checking the level of coolant in the radiator on a regular basis
- adding antifreeze as required in summer and winter.

Recognizes the effect of tire inflation on:

- tire wear
- traction, road handling and safety
- fuel efficiency.

Recognizes appropriate maintenance procedures for reducing/controlling corrosion of an automobile's:

- external body parts
- internal components.

Follows appropriate procedures for:

- maintaining an automobile battery
- jump starting an automobile.

Performs routine maintenance checks on personal/family automobile by examining:

- level of engine oil
- level of power steering and transmission fluid
- level of battery fluid
- level of coolant in the radiator
- tire pressure
- belts and pulleys for signs of wear.

Identifies parts of the car that need to be winterized and the equipment/processes used:

- cooling system (e.g., antifreeze, thermostat)
- engine (e.g, block heater)
- tire/braking system (e.g., appropriate tires for traction)
- fuel system (e.g., gas line antifreeze).

Related Applications Across the Curriculum

English

Selects and uses a variety of language arts skills when gathering and interpreting information about automobile technologies and safety features:

- develops technical vocabulary
- identifies cause and effect relationships
- observes sequence of events
- draws conclusions/makes inferences
- makes predictions
- summarizes
- uses visual/graphic information.

Uses appropriate note-taking strategies when gathering information about automobiles:

- selects relevant details
- uses an outline, flow chart and/or semantic web
- uses symbols and abbreviations.

Debates current issues related to safe travel:

- use of safety belts
- driver training
- driver age restrictions.

Mathematics

Measures distance, mass, force, volume, time and temperature as required when investigating technological devices and systems.

Applies ratio skills in developing an understanding of the concepts of:

- pressure
- mechanical advantage
- efficiency.

Uses problem-solving skills in diagnosing and repairing simple malfunctions in a technological system.

Recognizes Newton's laws of motion as applications of algebraic equations/formulas.

Uses statistical skills when collecting and analyzing data related to vehicle operation, repair and safety:

- tables/charts/graphs
- measures of central tendency
- probability.

Suggested Strategies/Activities

Plan activities that will enable students to investigate principles that govern the operation of component parts/subsystems within an automobile. Relate concepts learned to practical strategies that will assist students to operate and maintain a safe vehicle. This theme is not intended to develop expertise of a technical or mechanical nature.

Initial investigations may focus attention on the basic function of different subsystems in an automobile, and provide opportunities for students to analyze in some detail the operation of at least one of these subsystems. Following these activities, students will investigate the effects of first and second collisions in automobile accidents, and the subsequent need for safety technologies. Encourage students to consider personal risks involved in operating a vehicle, and to develop informed opinions regarding relevant safety issues.

Model strategies and skills that are appropriate to testing and/or designing a technological device. Assist students to relate specific skills that are used to an overall framework (see Methodology, "A Framework for Conducting Investigations in Science," pp. 25–26.) Additional suggestions for technological problem solving are provided in the *Teacher Resource Manual*: Science and Technology.

Encourage students to pose/answer questions about the automobile technologies they investigate:

e.g.,
- How does it work?
- How do I use it?
- How can I maintain/repair it?
- How can I improve it?

Students learn by reflecting on what they have done and will gain understanding by discussing and talking about their work. Provide opportunity for students to:

- work independently, as well as in small groups
- engage in group discussion where observations/procedures are shared
- summarize and explain outcomes to others.

Provide frequent opportunity for students to report, summarize and communicate the outcomes of investigation through informal writing activities. The process of writing enables students to sort/relate ideas and at the same time internalize observations and outcomes. Strategies that will support students in their use of writing skills are provided in the *Teacher Resource Manual*: Communication Skills.

LEARNING OBJECTIVES

CONCEPTS (continued):

DEMONSTRATES AN UNDERSTANDING THAT SIMPLE MAINTENANCE PROCEDURES CONTRIBUTE TO THE EFFICIENT PERFORMANCE AND GENERAL SAFETY OF AN AUTOMOBILE.

- Identifies subsystems/component parts that require routine maintenance checks.
- Describes common malfunctions that indicate service and/or repairs are required (e.g., muffler noise, steering problems).
- Outlines procedures to follow in "winterizing" an automobile.

DEMONSTRATES AN UNDERSTANDING THAT THE NATURE OF INJURIES SUSTAINED IN AN AUTOMOBILE ACCIDENT CAN BE ANTICIPATED BY CONSIDERING THE EFFECTS OF FIRST AND SECOND COLLISIONS.

- Relates Newton's laws of motion to the effects of first and second collisions in automobile accidents.
- Outlines energy conversions in an automobile collision, and relates energy transferred in a collision to the direction of moving objects involved.

DEMONSTRATES AN UNDERSTANDING THAT TECHNOLOGY HAS CONTRIBUTED TO SAFE TRAVEL THROUGH THE DEVELOPMENT OF HIGHWAY AND AUTOMOBILE SAFETY FEATURES.

- Explains principles that govern the operation of automobile safety technologies, including safety belt systems, padded dashboards and air bag systems.
- Describes other features of automobile design and highway design that contribute to safe travel.

DEMONSTRATES AN UNDERSTANDING THAT POLITICAL, ETHICAL, AND ECONOMIC PERSPECTIVES OFTEN INTERACT WITH SCIENCE AND TECHNOLOGY, INFLUENCING CHOICES AND DECISIONS THAT ARE MADE ABOUT SAFE TRAVEL.

- Summarizes recent statistical data that relates risk of automobile injury to travel speed, alcohol consumption and the use/non-use of seat belts.
- Identifies local laws, safety standards and licensing requirements that are designed to reduce risk of automobile injury.
- Identifies other perspectives (e.g., economic, environmental) that influence the development of automobile technologies and safety features.

Related Life Skills

Recognizes common malfunctions that indicate need for automobile maintenance and repair:

- tire noise
- failing lights and brakes
- muffler noise
- engine flooding
- alignment and steering problems.

Identifies various factors and conditions that affect the ability of a driver to operate a vehicle safely:

- driver training and experience
- alcohol consumption
- eyesight and general health
- environmental and road conditions
- condition of vehicle.

Recognizes the effect of travel speed on:

- braking distance
- types of injuries sustained in automobile accidents.

Anticipates how the passengers of a car may be affected by:

- changes in speed and direction
- sudden stops and collisions.

Explains how various automobile safety devices may reduce risk factors in highway travel:

- seat belt systems
- padded dash boards
- air bag systems
- shatter-proof windshields
- anti-burst door latches
- energy-absorbing steering columns.

Identifies highway safety features and explains their function in reducing automobile accidents:

- barrels of life
- guard rails
- break-away poles
- highway design (e.g., divided highways).

Understands the dangers associated with drinking and driving. Recognizes how the consumption of alcohol may cause motor vehicle accidents through its affect on the driver's:

- judgement
- reaction time
- vision and coordination.

Recognizes penalties for impaired driving offences and other vehicle operator violations.

Related Applications Across the Curriculum

Social Studies

Recognizes ways in which developments in automobile technology have affected:

- community/provincial/national business, industry and employment opportunities
- personal lifestyle
- the environment.

Recognizes laws/bylaws governing vehicle design and travel safety:

- safety belt laws
- hazardous goods routes
- speed limits
- licence restrictions.

Identifies political and economic issues that may affect vehicle design and travel safety regulations and laws.

Identifies future challenges of the automobile industry:

- improved safety features
- alternative energy sources.

Occupational Courses

Identifies potential occupational and entrepreneurial opportunities that involve operating/repairing selected automobile technologies.

Applies knowledge of scientific principles when operating/maintaining technological devices and systems in the workplace.

Demonstrates ability to use problem-solving and decision-making skills when:

- troubleshooting and repairing simple malfunctions in tools/equipment
- providing customer repair services.

Identifies safety procedures related to the use of technological products and processes in the workplace. Interprets appropriate safety symbols and signs.

Improvises simple devices that will assist in the accomplishment of specific tasks in the workplace:

- block and tackle systems
- ramps.

Suggested Strategies/Activities

Brainstorm and debate current problems/issues related to safe travel on the highway. Gather information by using learning resources that give a current perspective on the problems/issues that are identified (e.g., periodicals, films, videos, guest speakers). Structure discussion by using semantic webs, idea diagrams and critical thinking skills (see *Teacher Resource Manual*: Communication Skills).

Students need to understand that although technology contributes to the solution of many practical problems, it also creates other problems in society. Select activities that will enable students to identify:

- technological products/designs that have been developed in response to our need for safe and reliable transportation
- other safety and/or environmental problems created as a result of the development of particular transportation technologies.

Suggestions for evaluating students' performance throughout investigations in this theme are provided in the *Teacher Resource Manual* (see Assessment/Evaluation). Teachers are encouraged to use a variety of assessment techniques (e.g., observation, interview, diagnostic writing assignments) in determining how students approach "doing" science, and to document learning outcomes and behaviours through the use of appropriate checklists and inventories.

Community Partnerships:

- Visit a local garage/automobile shop and examine the subsystems/component parts in an automobile. Ask a mechanic to:
  - demonstrate the operation of different subsystems
  - discuss appropriate procedures for maintaining each system of the family car.
- Visit a local autobody shop and investigate the effects of corrosion on parts of an automobile. Ask an attendant to discuss practical strategies for:
  - repairing corroded parts
  - inhibiting/controlling corrosion.
- Visit a local automobile dealership. Ask a sales representative to illustrate various safety technologies that have been developed for new cars.
- Invite a representative from the Alberta Motor Association or a local "driver education" program to discuss the risks of highway travel/strategies for driving safely.
- Invite a local MLA, alderman or councillor to discuss recent laws/regulations/debate with respect to safety on the highway.
- Invite a police officer/insurance agent to discuss statistics related to automobile accidents and penalties for various driving offenses.
- Invite a representative of the Motor Vehicles Branch to discuss legal/safety factors related to owning and operating a vehicle.
- Interview an engineer who designs highways, discussing various safety features that are incorporated into highway design.

SCIENCE 26

ENERGY AND THE ENVIRONMENT

OVERVIEW:

This theme focuses attention on the students' use of energy, and examines applications of energy systems in everyday living. Students will investigate renewable and non-renewable energy sources, and consider the environmental and societal implications of various energy alternatives. Students will also formulate strategies for monitoring personal consumption of electrical energy in the home, and develop an understanding of the impact of an increasing population on energy requirements and environment.

A major emphasis will be placed on developing a process for building consensus on energy-related issues through research, discussion and debate. Students will apply previously developed knowledge of ecology and the biosphere (see Science 16: Caring for Environment and Resources) throughout this theme as they consider the effects of alternative energy-use practices on the environment. Learning objectives interrelate with a prior theme, Personal Health and Lifestyle, and will assist students to understand how environmental factors may influence personal health. Learning objectives also interrelate with Technology in Transportation, and contribute to an understanding of current energy issues related to automobile technology and travel.

ATTITUDES:

Students will be encouraged to:

- display a positive attitude toward the learning of concepts and skills in science by
  - showing interest and curiosity through willingness to ask questions, share observations and ideas, and seek answers
  - performing investigations and completing assignments independently and in cooperation with others
- appreciate the fragility of the biosphere
- appreciate the interdependence of self with other living forms and with the environment
- appreciate that environmental issues involve significant relationships among science, technology and society
- realize our inability to anticipate the environmental effects of human activities
- appreciate that the collective action of individuals can have significant impact
- develop a sense of personal responsibility in relation to environmental issues.

LEARNING OBJECTIVES

SKILLS:

DEMONSTRATES ABILITY TO IDENTIFY AN ENVIRONMENTAL ISSUE RELATED TO THE LOCAL USE OF ENERGY RESOURCES, TO CONSIDER FACTORS RELATED TO THE ISSUE, AND TO APPLY RELATED INFORMATION IN DEVELOPING AN ACTION PLAN TO DEAL WITH THE ISSUE.

- Identifies an environmental issue related to the local use of energy resources.
- Gathers information related to the issue through observation, interview and/or research.
- Designs an investigation, through class discussion, that illustrates how particular practices and/or products are related to the issue and influence environmental quality.
- Analyzes and assesses information by identifying patterns and relationships, by judging the reliability/validity of information gathered, and by considering consequences.
- Communicates the results of investigation verbally, through the use of models and diagrams, and/or through written expression.
- Takes an informed position on the issue, identifying strategies that may be used to deal with the situation.

CONCEPTS:

DEMONSTRATES AN UNDERSTANDING THAT DIFFERENT FORMS OF ENERGY ARE USED AT HOME AND IN WORK-RELATED SITUATIONS.

- Identifies major forms of energy (e.g., mechanical, light, sound, heat, electrical, chemical) and explains their applications in familiar technologies.
- Distinguishes between potential energy (i.e., stored energy) and kinetic energy (i.e., energy of movement) in practical situations.

DEMONSTRATES AN UNDERSTANDING THAT THERE ARE RENEWABLE AND NON-RENEWABLE SOURCES OF ENERGY.

- Gives examples of renewable energy sources (e.g., solar, wind, geothermal) and their value in providing for energy requirements.
- Gives examples of non-renewable energy sources (e.g., fossil fuels) and societal issues arising from their use.

Related Life Skills

Appreciates how some of our non-renewable energy resources have been formed over millions of years by geological processes that may never be repeated. Develops strategies that will ensure the efficient use of non-renewable energy resources.

Appreciates contributions of science and technology in:

- providing adequate amounts of energy for everyday use
- attempting to develop alternative energy sources to meet the changing needs of society.

Relates knowledge of energy issues to personal energy consumption in the home:

- reads "energy guide" labels on home appliances
- classifies home appliances/ technologies as high, medium and low energy users
- recognizes energy costs associated with the use of these devices
- identifies strategies that might be used in reducing energy consumption in the home.

Monitors household consumption of energy by reading electrical/natural gas utility meters.

Compares energy consumption/costs associated with various forms of transportation:

- walking/bicycle
- public transportation
- automobile.

Selects the most energy-efficient method of transportation when it is practical to do so.

Applies knowledge of energy systems in troubleshooting and repairing simple technologies used in the home:

- identifies energy source used to power the technology
- detects energy transformations that occur within the device
- isolates component parts and infers how each part contributes to the functioning of the "system".

Related Applications Across the Curriculum

English

Reads and interprets environmental information presented in newspapers, magazines, books and media sources.

Examines current community, provincial, national and global energy and environmental issues.

Uses note-taking and reporting skills when gathering, organizing and recording information related to energy and environmental issues:

- selects suitable information sources
- uses an appropriate strategy to organize information
- summarizes
- synthesizes notes
- edits rough drafts.

Evaluates the results of investigation and the process used through group discussion:

- differentiates between fact and fiction
- compares results with classmates
- examines the problem-solving model used.

Mathematics

Uses statistical skills when gathering, recording, and organizing information related to energy and environmental issues:

- conducts a survey or poll in the local community
- determines appropriate measures of central tendency (e.g., mean, median, mode, range)
- gathers and records data using tally sheets and frequency tables
- reads and interprets information provided in list/table/chart/graph form
- organizes and displays data in table/chart/graph form.

Performs calculations as required when monitoring electrical energy consumption/costs in the home.

Uses ratio/percent skills when interpreting energy efficiency ratings.

Suggested Strategies/Activities

Develop an understanding of concepts and skills through learning activities that provide a current perspective on local energy issues and problems. Instruction should enable students to recognize:

- their dependence on energy systems
- energy-use issues that are a matter of current concern in the local community
- strategies for dealing with energy and environmental issues/problems.

Assist students to develop the required knowledge base by providing a variety of "input" activities.

e.g.,
- films/videos/computer software
- field trips into the local environment
- guest speakers from local energy suppliers and energy conservation agencies
- research (newspapers, magazines, booklets/ pamphlets available from local utility companies and environmentalist groups).

Illustrate to students how the framework for conducting investigations in science (see pp. 25–26) provides an overall structure that can help them to investigate energy and environmental issues. Discuss and model skills that may be appropriately used throughout the investigative process.

e.g.,
- defining a problem or issue
- using an experimental design or research plan
- looking at both sides of an issue (i.e., economic vs environmental)
- looking for patterns and relationships
- considering consequences
- developing consensus within a group.

Additional suggestions for investigating and resolving environmental issues are provided in the *Teacher Resource Manual*: Science, Technology and Societal Issues.

Encourage students to assimilate, organize and summarize information they gather by drawing "idea diagrams" and "semantic webs" (see *Teacher Resource Manual*: Communication Skills). Prompt students to recall ideas through brainstorming activities and by asking appropriate chains of questions.

e.g.,
- Why did . . . happen?
- What might happen if . . .?
- How does . . . cause . . .?

LEARNING OBJECTIVES

CONCEPTS: (continued)

DEMONSTRATES AN UNDERSTANDING THAT ENERGY SYSTEMS HAVE INPUT, CONVERSION AND OUTPUT COMPONENTS.

- Explains how living organisms (e.g., plants, the human body) are energy systems having input, conversion and output components.
- Traces energy flow in a simple technological system, identifying input, conversion and output components.

DEMONSTRATES AN UNDERSTANDING THAT THE TOTAL ENERGY OF A SYSTEM IS CONSERVED.

- Illustrates, by referring to a simple energy system model, how energy is neither created nor lost, but converted from one form to another in energy systems.
- Constructs energy chains that trace forms of energy used in familiar technologies back to other sources.

DEMONSTRATES AN UNDERSTANDING THAT ENERGY EFFICIENCY RATINGS DESCRIBE THE PORTION OF INPUT ENERGY THAT IS CONVERTED TO USEFUL ENERGY.

- Compares and contrasts two simple energy systems in terms of their overall efficiency.
- Suggests ways of improving the efficiency rating of a familiar energy system through modifications in design.

DEMONSTRATES AN UNDERSTANDING THAT CONSUMPTION OF ELECTRICAL ENERGY IN THE HOME CAN BE ANALYZED AND MONITORED.

- Identifies major components of electrical energy systems used in the home (i.e., energy source, distribution system, conversion and output components).
- Determines the amount and cost of electrical energy consumed by familiar appliances/technologies in the home.
- Interprets electric utility meters and account statements.
- Describes appropriate strategies for reducing consumption of electrical energy.

DEMONSTRATES AN UNDERSTANDING THAT ENERGY CONSERVATION INVOLVES THE INTERACTION OF ECONOMIC, POLITICAL AND ETHICAL PERSPECTIVES WITH SCIENCE AND TECHNOLOGY.

- Explains how energy conservation practices must include consideration of a number of factors, including:
  - the availability/supply of energy resources
  - the effects of alternative forms of energy on the environment
  - the cost of producing different forms of energy
  - efficient use of energy at local, national and international levels.
- Describes recent contributions of science and technology in the field of energy conservation.

Related Life Skills

Understands that in order to maintain a particular body weight, one must balance energy intake and energy output (i.e., balance diet and exercise).

Evaluates energy content of personal diet:

- recognizes basal metabolic rate
- compares daily energy intake to daily energy output
- adjusts diet as required.

Recognizes advantages of having a well-insulated home:

- increased comfort
- reduced energy consumption
- lower fuel bills.

Identifies major sources of heat loss in the home. Develops strategies that are effective in reducing heat loss and energy consumption in the home.

Appreciates that the environment is affected by our use of fossil fuels:

- acid rain
- greenhouse effect.

Accepts the need for developing alternative sources of energy in order to reduce environmental impacts of present energy practices.

Recognizes alternative energy sources that may play a significant role in providing for our future energy needs:

- solar energy
- nuclear energy
- wind energy
- geothermal energy.

Understands potential applications of solar energy in the home:

- central heating
- energy for appliances.

Identifies ways in which individuals and society can become involved in resolving issues related to our use of energy and the environment:

- personal habits
- lobby groups
- voting
- provision of fiscal/manpower resources.

Related Applications Across the Curriculum

Social Studies

Considers how our use of energy and the environment may affect:

- present and future employment opportunities
- quality of life
- costs of living.

Identifies agencies/practices in the local community that foster environmental awareness and conservation of energy resources:

- recycling programs
- car pooling and using public transit system
- second-hand stores, rummage sales.

Identifies environmental issues/problems of local, provincial, national and international significance. Uses decision-making skills to develop alternative strategies for dealing with these issues:

- disposal of refuse
- decreasing levels of acid rain.

Realizes that, as citizens and voters, we frequently encounter issues relating to energy and the environment. Accepts responsibility, as a member of democratic society, to conserve energy resources and protect the environment.

Occupational Courses

Appreciates the need for energy conservation in the workplace. Recognizes short-term and long-term effects of inappropriate energy-use practices on others and the environment.

Identifies appropriate strategies for:

- monitoring the amount/cost of electrical energy consumed in producing a product or providing a service
- minimizing the environmental impact of materials, procedures and energy used in the workplace.

Recognizes occupational and entrepreneurial opportunities that exist in areas that involve the production and/or conservation of energy.

Suggested Strategies/Activities

Emphasize the use of critical thinking skills. Students need to be encouraged to consider all factors and viewpoints related to a given issue, and to justify the conclusions drawn and the personal action plans adopted. A variety of strategies that will guide students through the process of analysis and critical thought have been provided in the *Teacher Resource Manual*: Communication Skills, "Using Critical Thinking Skills".

e.g.,
- PMI (Plus-Minus-Interesting)
- CAF (Consider All Factors)
- OPV (Other People's Views)
- C and S (Consequences and Sequels).

Provide frequent opportunity for students to report, summarize and communicate the outcomes of investigations and discussion through informal writing activities. The process of writing enables students to sort and relate ideas, and helps the learner to internalize observations and outcomes. Strategies that will support students in their use of writing skills are provided in the *Teacher Resource Manual*: Communication Skills, "Summarizing, Evaluating and Communicating Ideas in Science".

Community Partnerships:

- Invite a wildlife officer, agriculturalist, forestry official or environmentalist to discuss concerns related to local use of energy and the environment.
- Visit local business/industry and observe how energy is used in various technologies (e.g., service station, manufacturing plant, construction site).
- Visit a local power generating plant and note the energy transformations/technologies used in producing electrical energy.
- Invite a representative from the local electrical or natural gas utility company to discuss energy consumption/costs/conservation in the home.
- Visit local companies involved in extracting, refining or using fossil fuels. Investigate the effects of these processes on the environment.
- Visit a solar efficient building and note energy transformation/conservation.
- Invite an engineer/environmentalist to discuss issues relating to local energy supply and use.
- Invite local aldermen, councillors or MLA's to discuss current policy/debate/legislation relating to energy and the environment.

SAMPLE OPTIONS

Teachers may wish to use the elective component of Science 26 to enrich the science program through the study of optional content. While there is no requirement that optional content be included in the science program, two optional topics have been provided as a service to teachers:

- Food and Microbes
- Using Light and Sound.

The outlines that follow will assist teachers who wish to develop these topics as optional content.

FOOD AND MICROBES

OVERVIEW:

This topic is intended to develop an understanding of the role of micro-organisms in food production and in food spoilage. Activities will enable students to investigate the use of various technologies in preparing, preserving and protecting our food. Students should recognize safety standards for preparing and handling foods, and anticipate health problems that may result if safety standards are not maintained.

ATTITUDES:

- Appreciates the relationship between science and technology.
- Appreciates the contributions of science and technology in developing safe methods of preparing and preserving food products.
- Displays responsible attitudes toward the preparation and handling of food.

SKILLS:

- Uses the skills of science to investigate the effects of molds, yeasts and bacteria on foods under varying circumstances/conditions.
- Identifies common symptoms of food poisoning and appropriate recovery techniques.
- Follows appropriate procedures for preparing, preserving and handling familiar foods.

CONCEPTS:

- Describes the useful/harmful properties of bacteria, yeasts and molds.
- Demonstrates an understanding of the role of microbes in the production of various foods (e.g., bread, wine, beer, cheese, yogurt).
- Explains the role of microbes in food spoilage.
- Identifies health problems that result from improper food preparation and handling procedures.
- Demonstrates an understanding of technological processes used in preserving and protecting human food (e.g., drying foods, using additives, using acids, preserving with heat/cold).
- Describes safety standards for preparing and handling foods.

USING LIGHT AND SOUND

OVERVIEW:

Learning objectives will focus attention on basic scientific principles related to the behaviour of light and/or sound. Students will apply the scientific principles they investigate in developing explanations of natural phenomena, as well as in explaining the operation of familiar optical and/or acoustical technologies. Activities should provide opportunities for students to examine, test and construct simple devices/systems that illustrate technological applications of light and/or sound.

ATTITUDES:

- Appreciates the utility of scientific processes/skills in explaining natural phenomena.
- Develops confidence in personal ability to understand and solve practical problems through the use of science and technology.
- Appreciates the relationships among science, technology and society.

SKILLS:

- Uses the skills of science to investigate scientific facts, laws and theories related to light and/or sound.
- Analyzes, tests and troubleshoots simple optical and/or acoustical devices, identifying component parts and scientific principles that are utilized.
- Uses a problem-solving strategy to design and construct a simple technology that applies basic principles of light and/or sound.

CONCEPTS:

- Explains, by giving examples, how scientific knowledge about light and/or sound is used to solve practical problems and satisfy human needs/wants.
- Demonstrates an understanding of basic scientific principles associated with the functioning of familiar optical and/or acoustical devices.
- Gives examples of familiar technological systems consisting of combinations of different subsystems (e.g., optical, acoustical, electrical, mechanical) that work together in accomplishing a particular task.
- Demonstrates an understanding of new/emerging technologies that involve the application of knowledge about light and/or sound.

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